1/88

FIG 1A

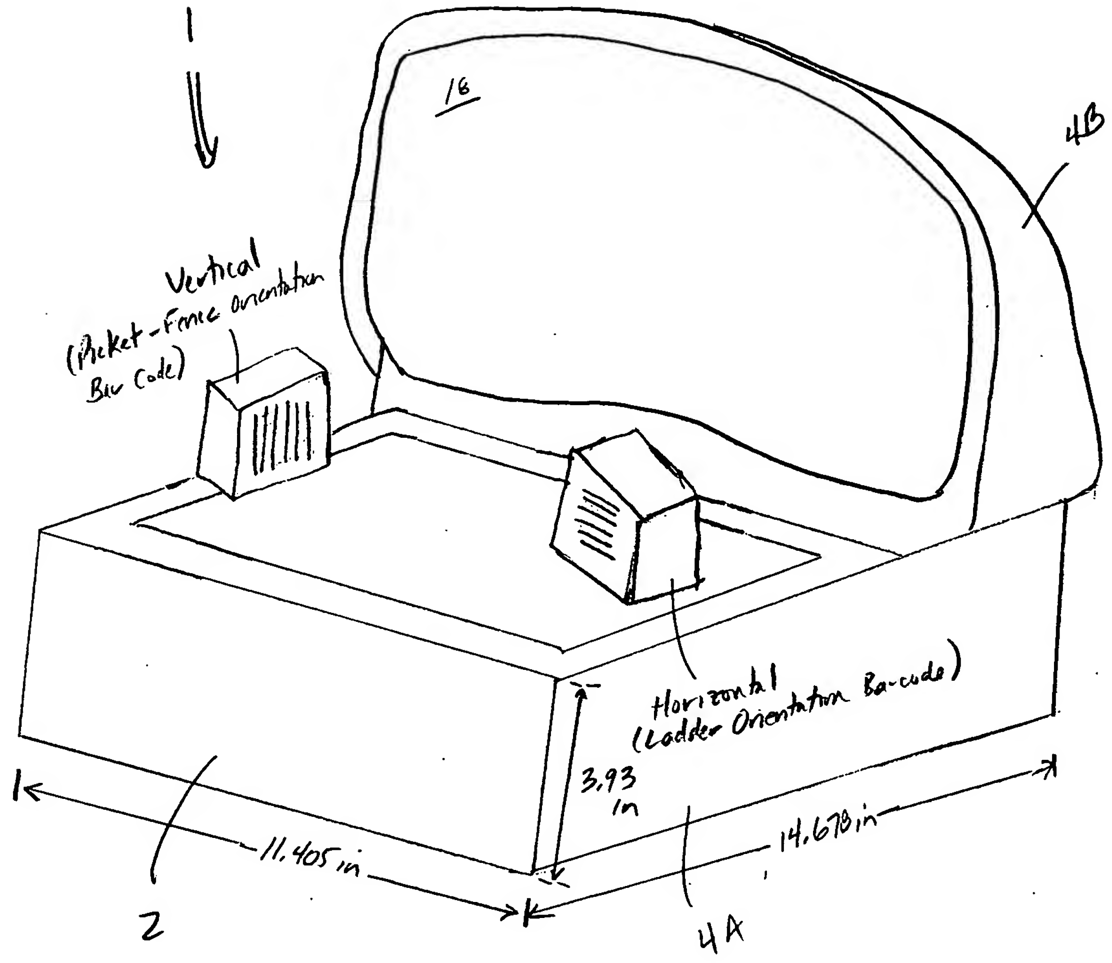

1
18
4B
Vertical
(Picket-Fence Orientation Bar Code)
Horizontal
(Ladder Orientation Bar-code)
3.93 in
11.405 in
14.678 in
2
4A

FIG. 1B

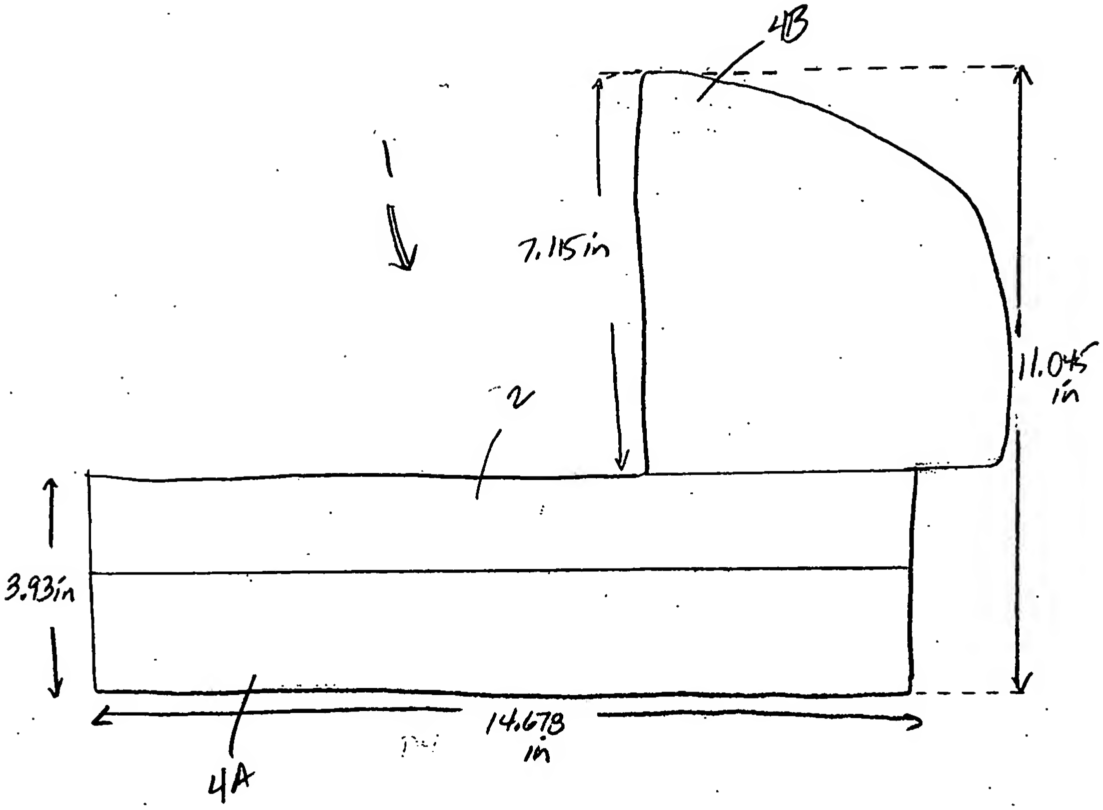
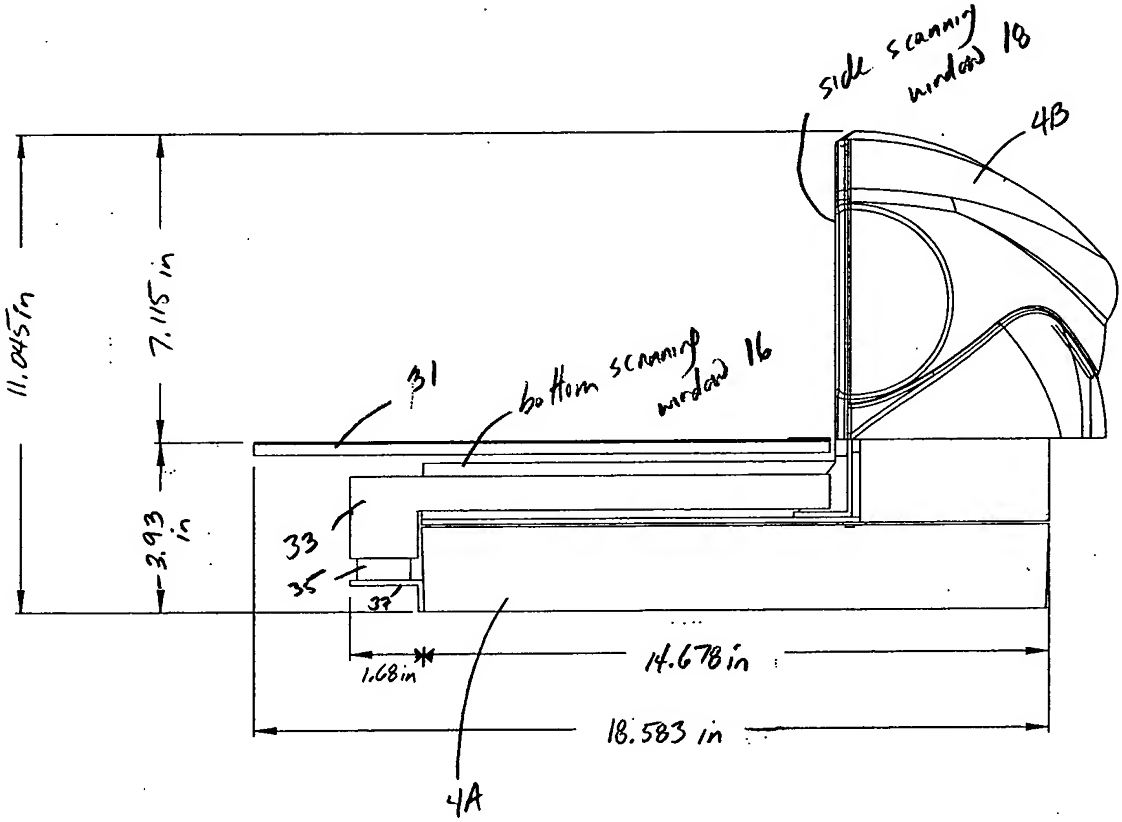
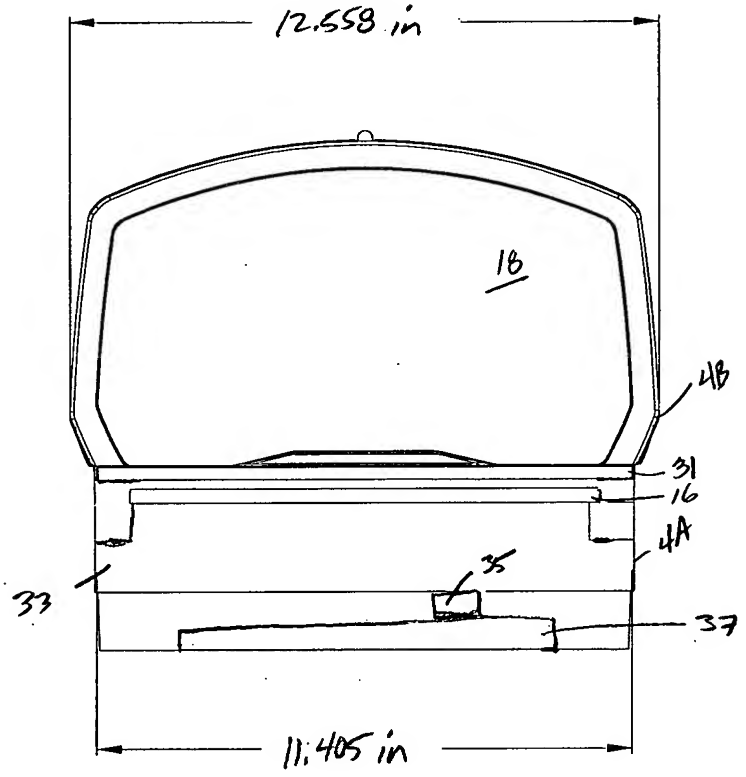

4B
1
7.115 in
2
11.045 in
3.93 in
14.678 in
4A

FIG. 1C


side scanning window 18
4B
11.045in
7.115 in
31
bottom scanning window 16
33
35
37
3.93 in
1.68in
14.678in
18.583 in
4A

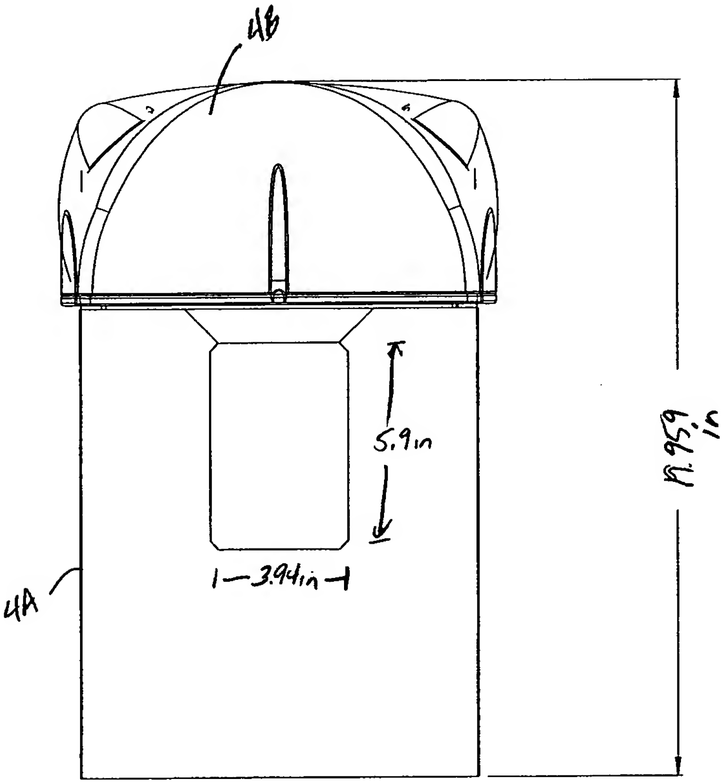
10045805 .011102

FIG. 1D


12.558 in
18
4B
31
16
4A
35
33
37
11.405 in

10045605 .011102

FIG. 1E


4B
5.9in
3.94in
17.959 in
4A

10045605 .011102

FIG. 1F

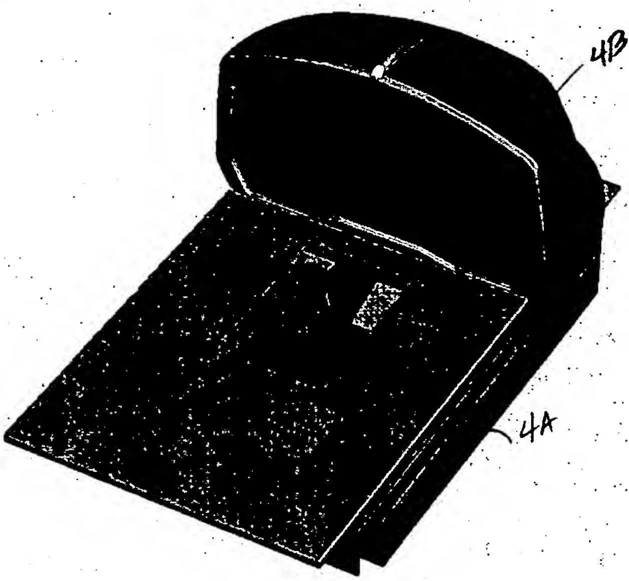
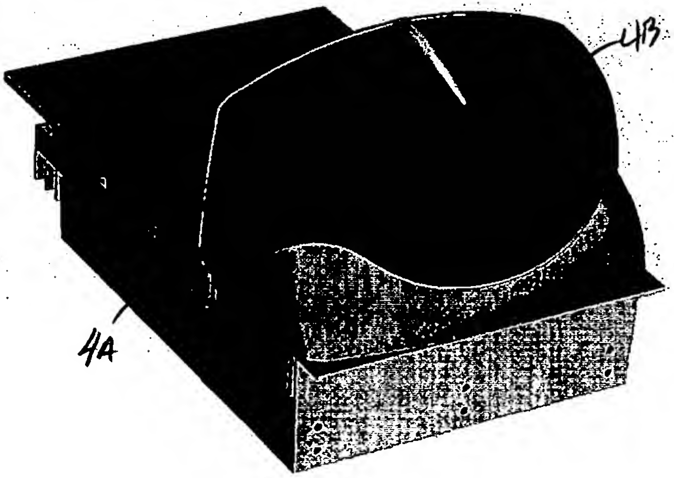


FIG. 1G



10045605.011102

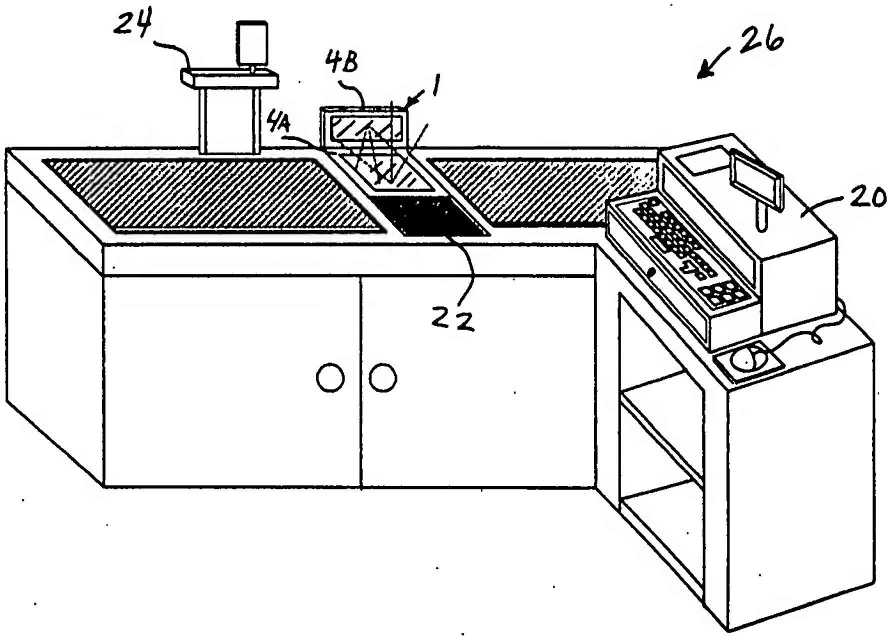

24
4B
1
4A
26
20
22

FIG. 1H

10045605.011102

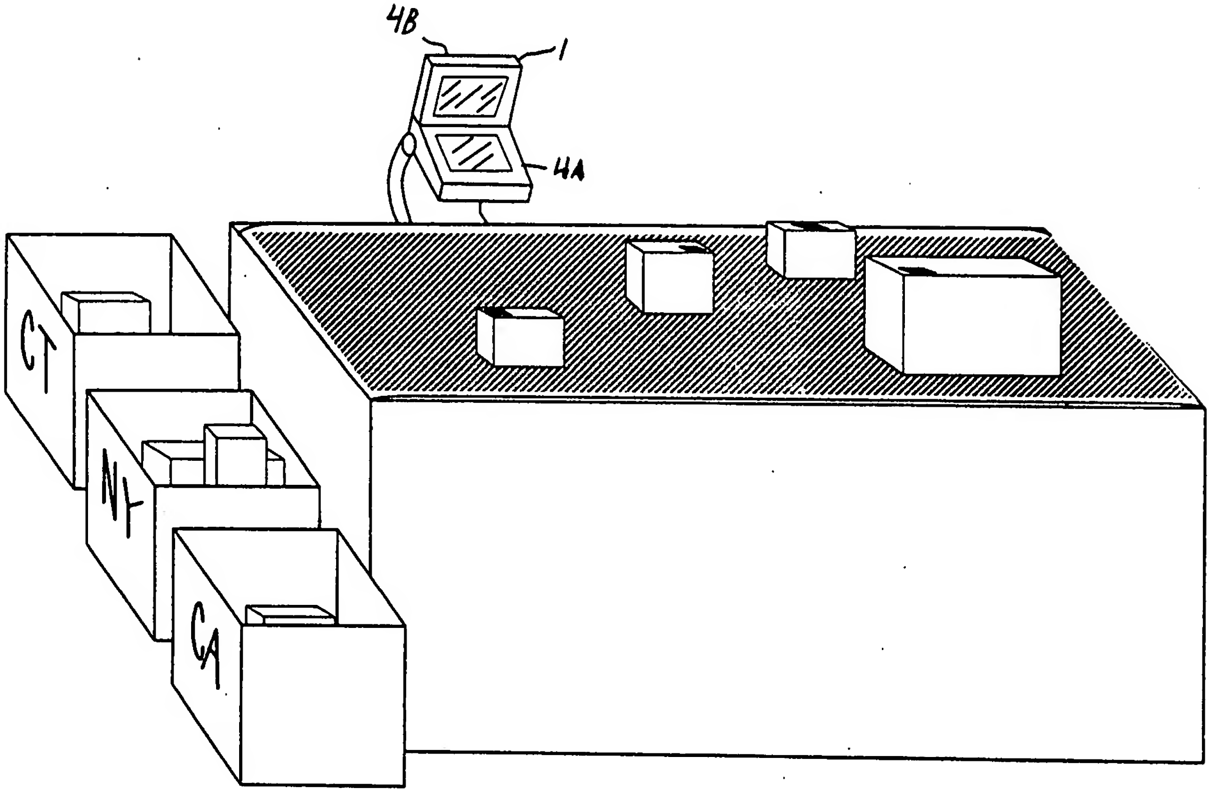
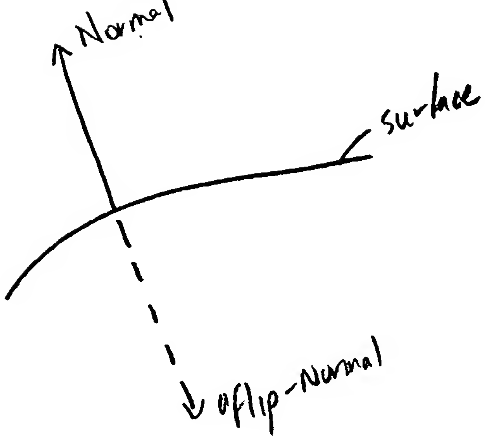

4B
1
4A
CT
NY
CA

FIG. 1E

FIG. 1J


Normal
surface
oflip-Normal

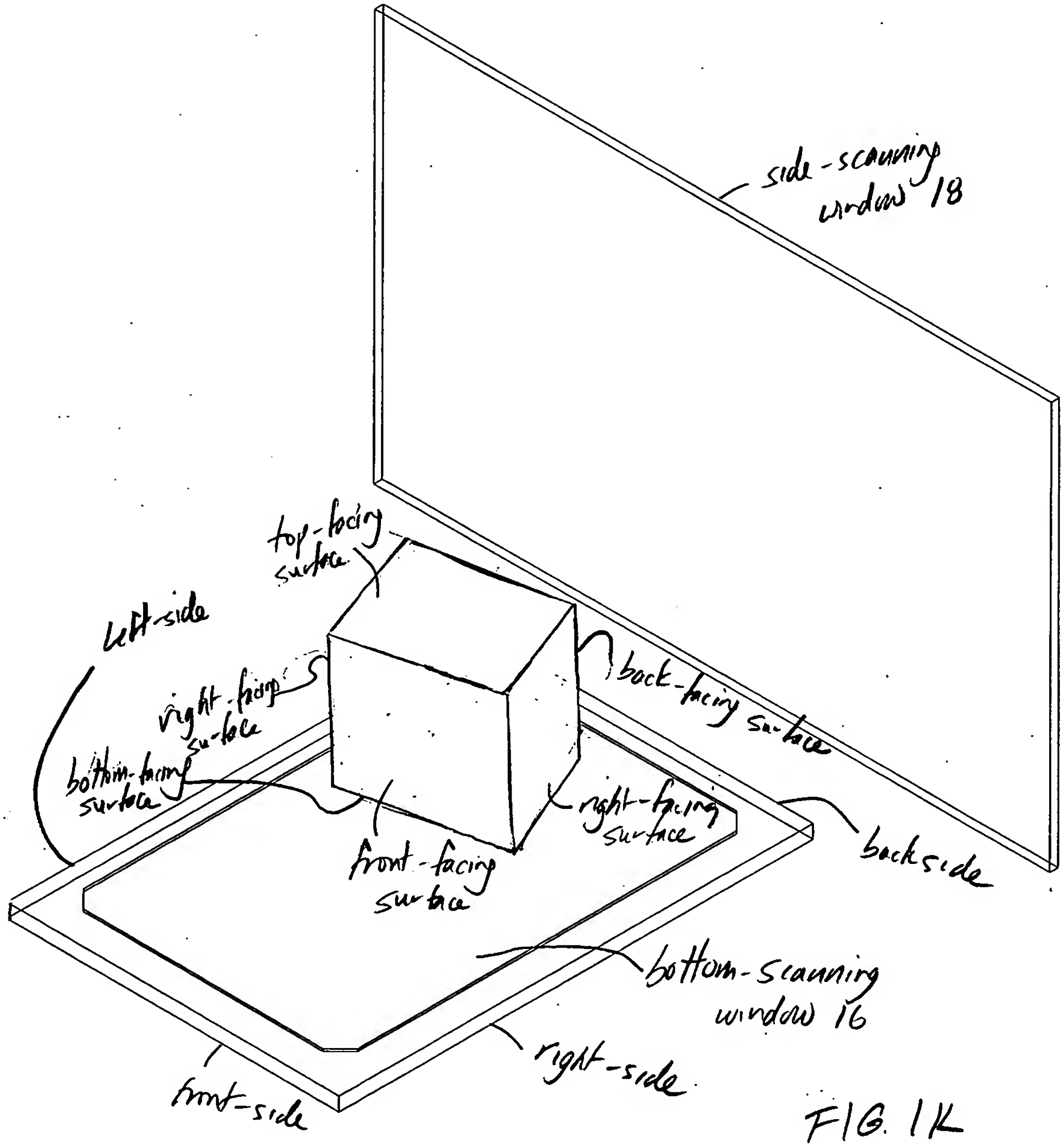

side-scanning window 18
top-facing surface
left-side
right-facing surface
back-facing surface
bottom-facing surface
right-facing surface
backside
front-facing surface
bottom-scanning window 16
right-side
front-side

FIG. 1K

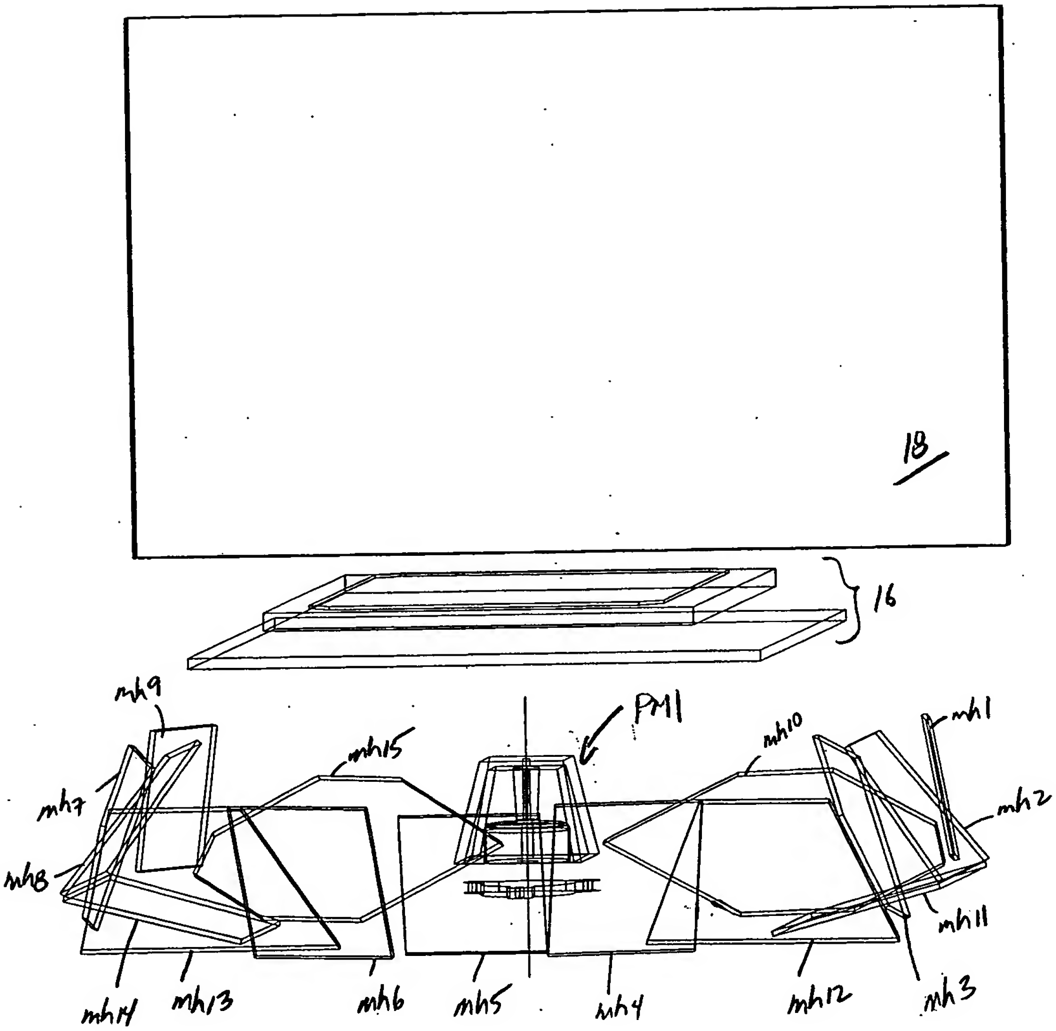

18
16
PM1
mh1
mh2
mh3
mh4
mh5
mh6
mh7
mh8
mh9
mh10
mh11
mh12
mh13
mh14
mh15

FIG. 2A

10095962 .071502

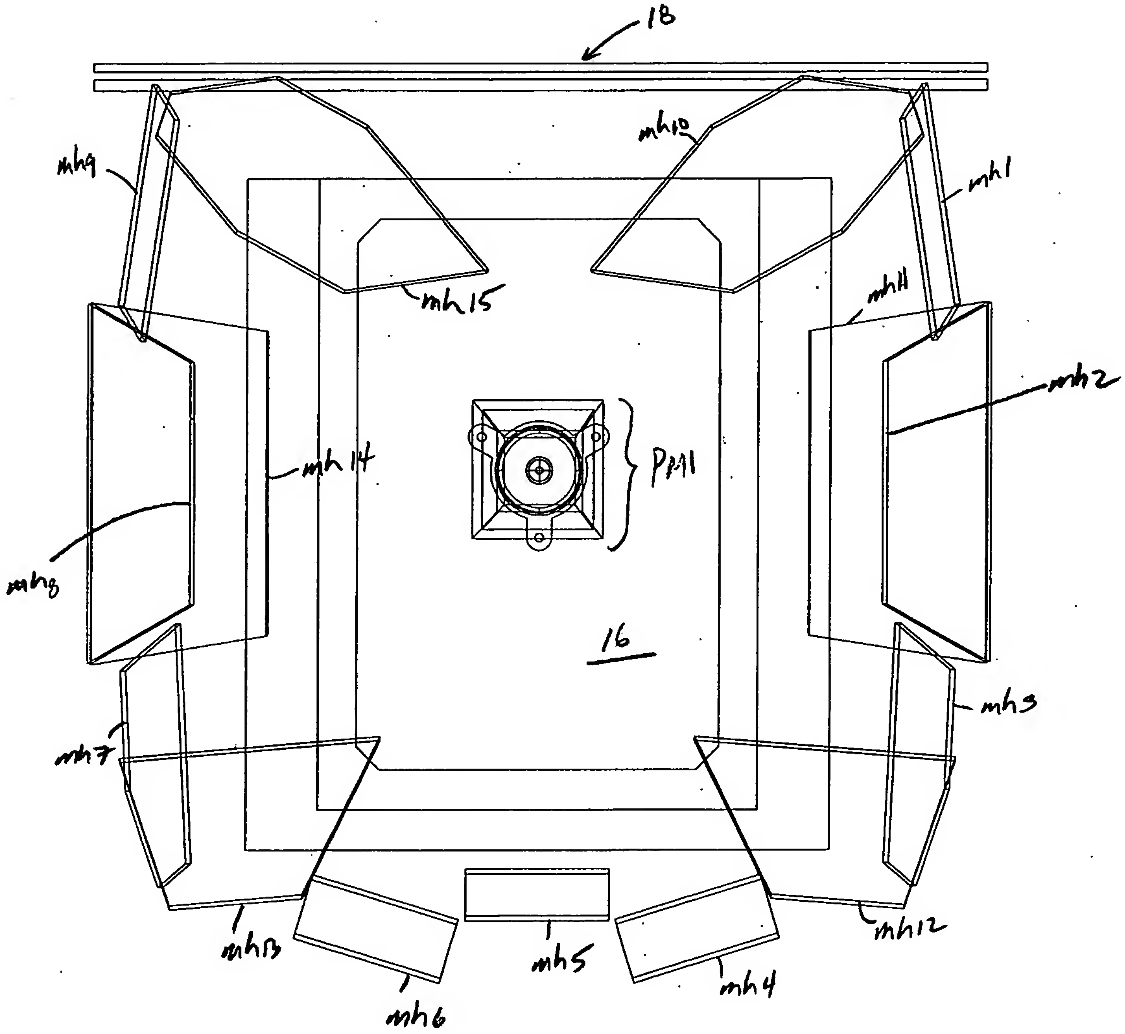

18
mh9
mh10
mh1
mh15
mh11
mh2
mh14
PM1
mh8
16
mh3
mh7
mh13
mh5
mh12
mh6
mh4

FIG. 2B

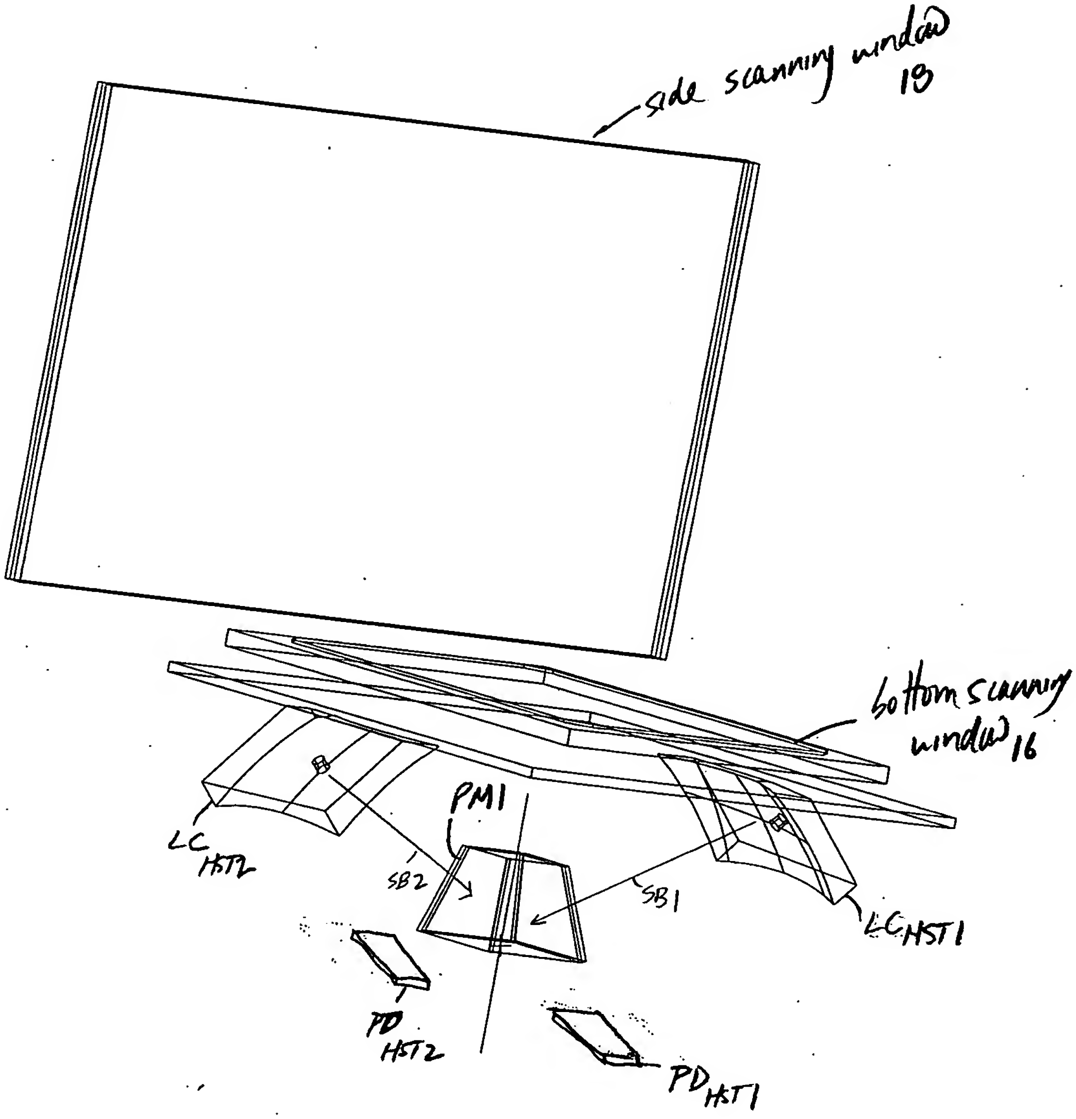

side scanning window 18
bottom scanning window 16
PM1
LC$_{HST2}$
SB2
SB1
LC$_{HST1}$
PD$_{HST2}$
PD$_{HST1}$

FIG. 2CT

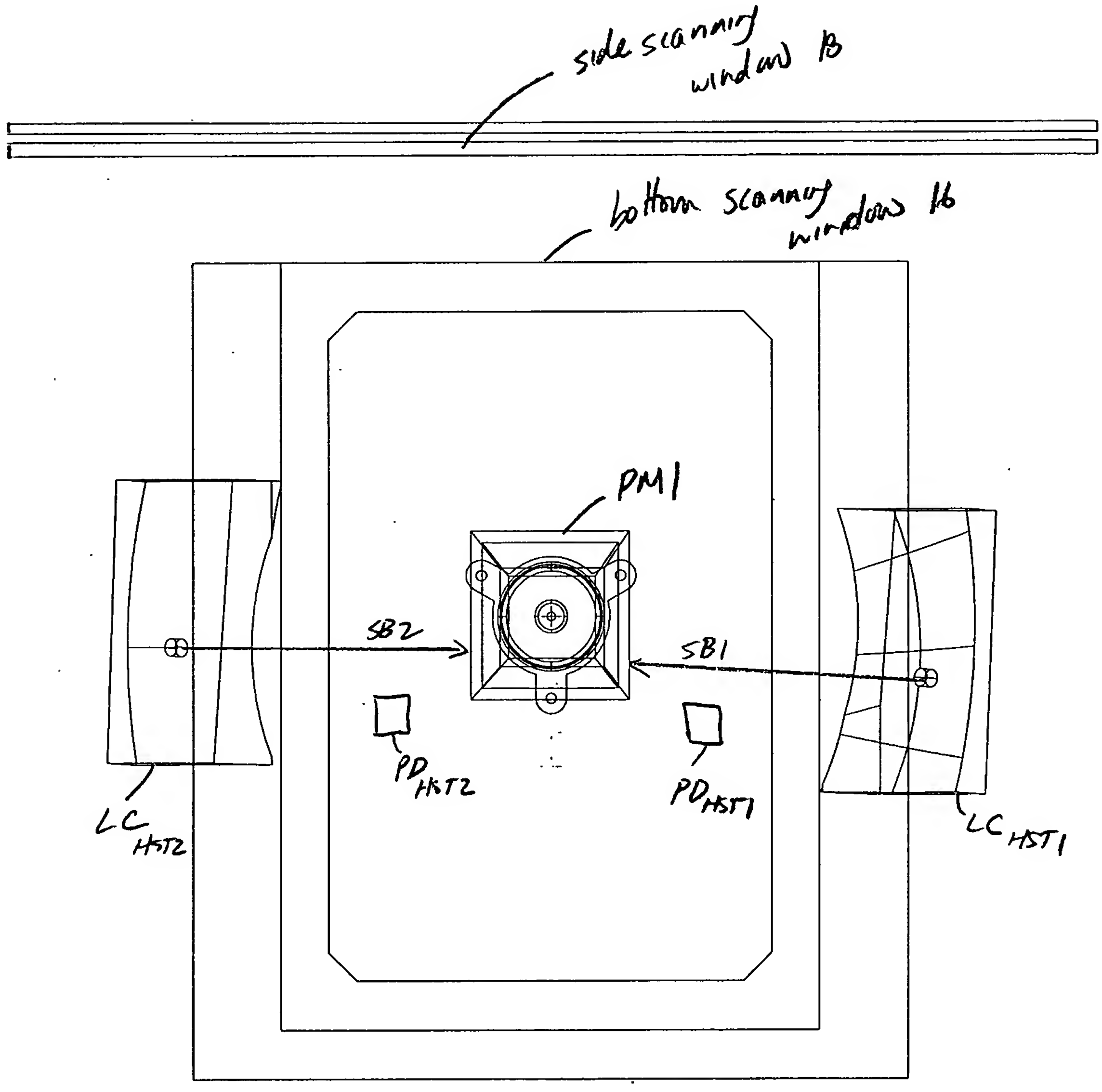

side scanning window 18
bottom scanning window 16
PM1
SB2
SB1
PD_{HST2}
PD_{HST1}
LC_{HST2}
LC_{HST1}

FIG. 2C2

30718360 " 80L3LPE

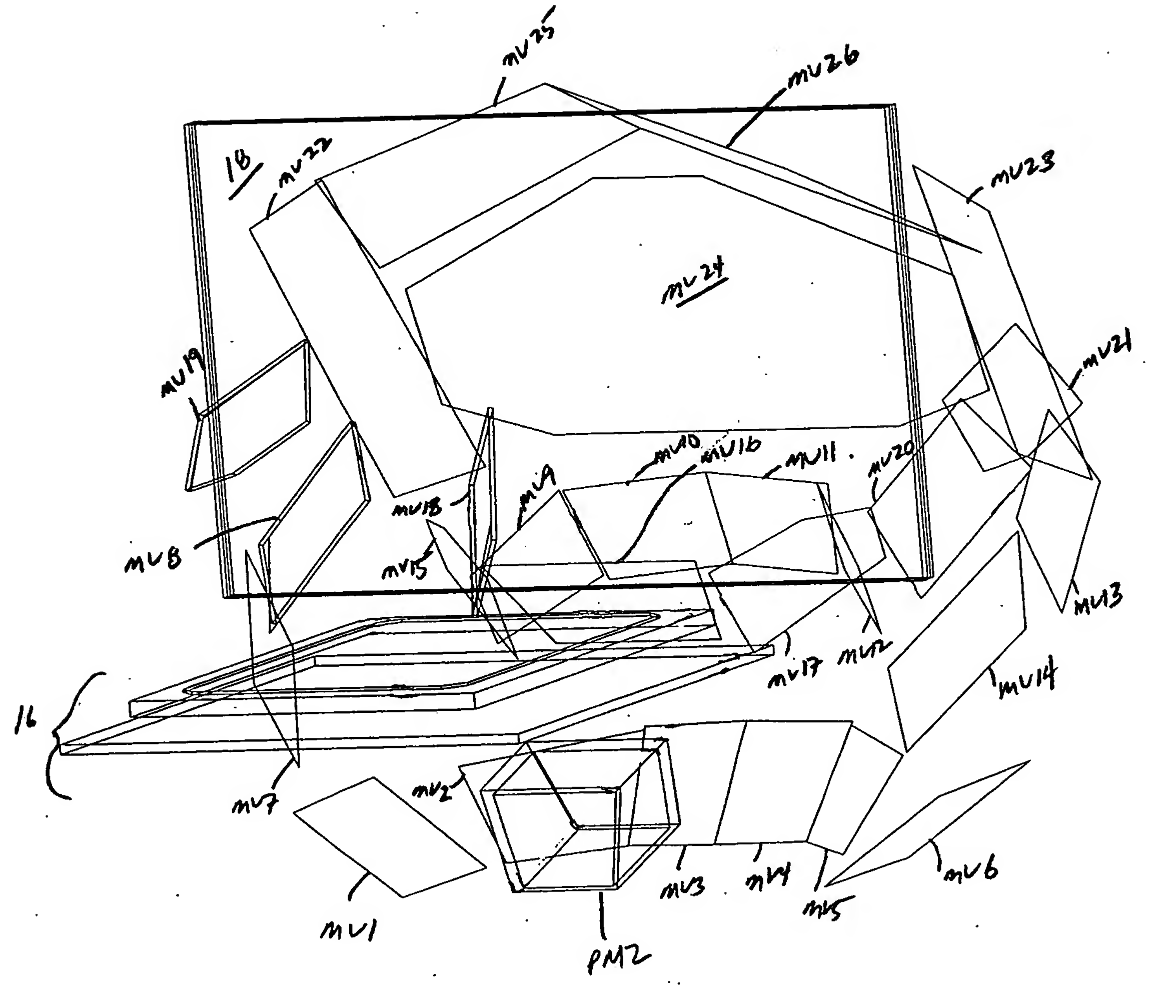

MV25
MV26
18
MV22
MV23
MV24
MV19
MV21
MV10
MV16
MV11
MV20
MV18
MV9
MV8
MV15
MV13
MV17
MV12
MV14
16
MV7
MV2
MV3
MV4
MV5
MV6
MV1
PM2

FIG. 2D

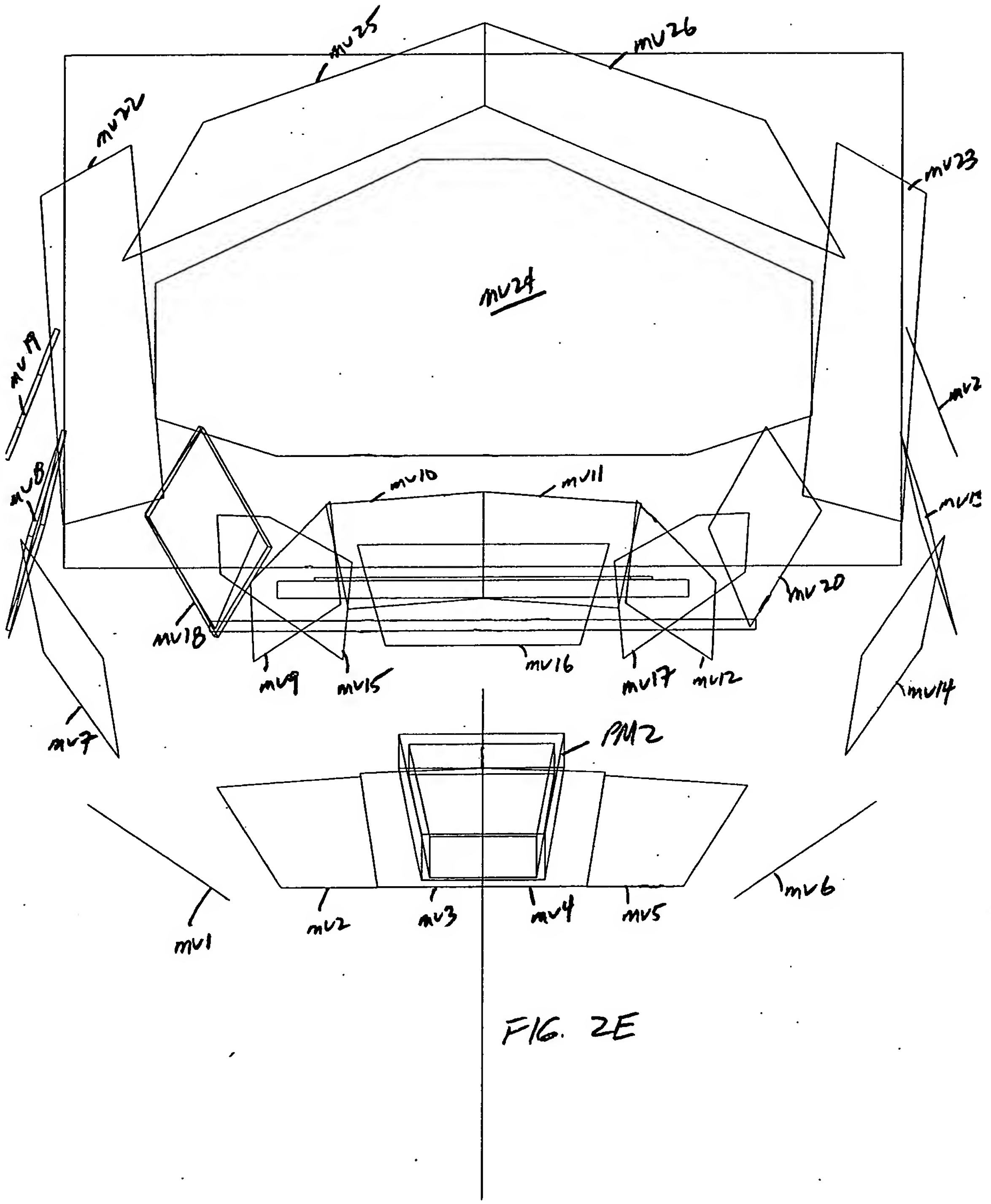

mv25
mv26
mv22
mv23
mv24
mv19
mv2
mv8
mv
mv10
mv11
mv18
mv20
mv9
mv15
mv16
mv17
mv12
mv14
mv7
PM2
mv1
mv2
mv3
mv4
mv5
mv6

FIG. 2E

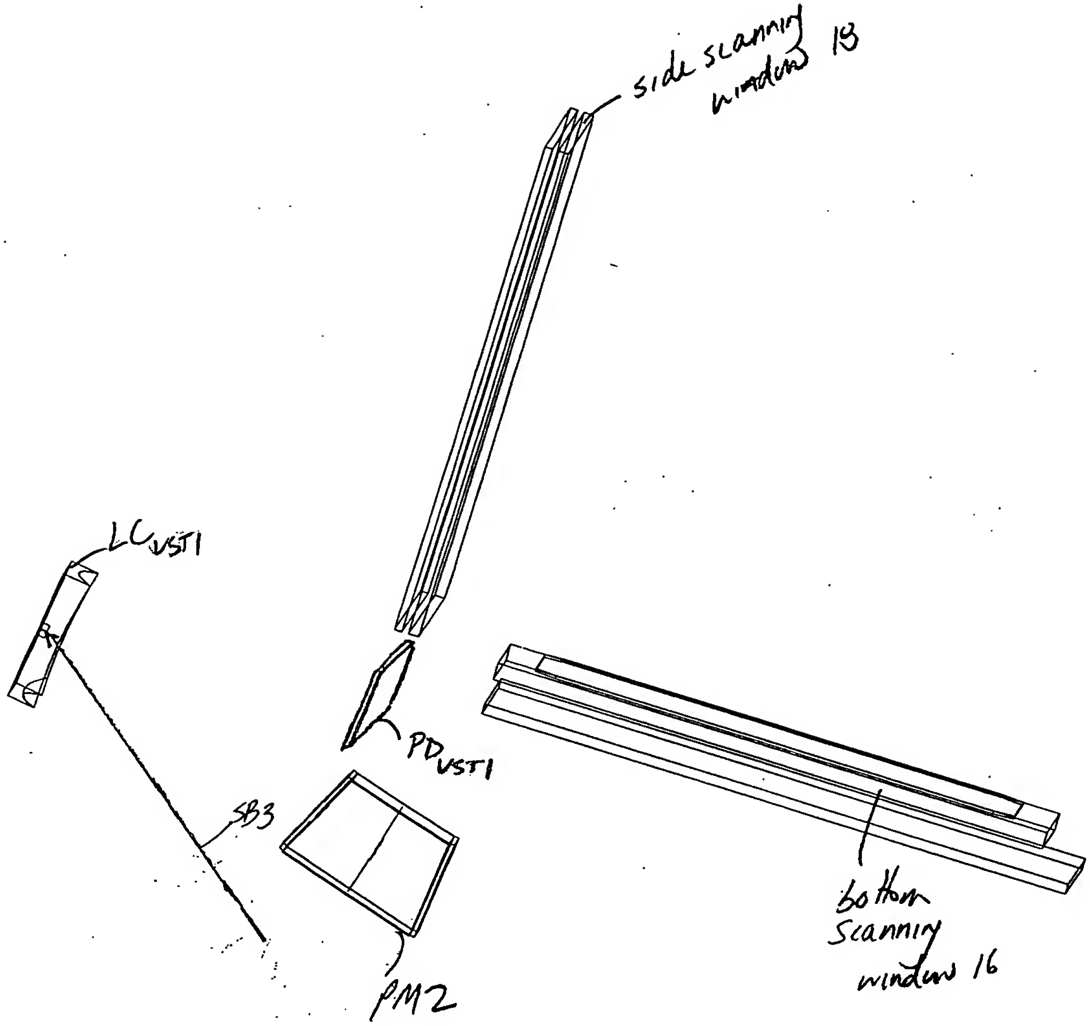
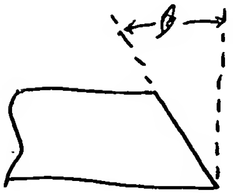

side scanning window 18
LC$_{VST1}$
PD$_{VST1}$
SB3
PM2
bottom scanning window 16

FIG. 2F

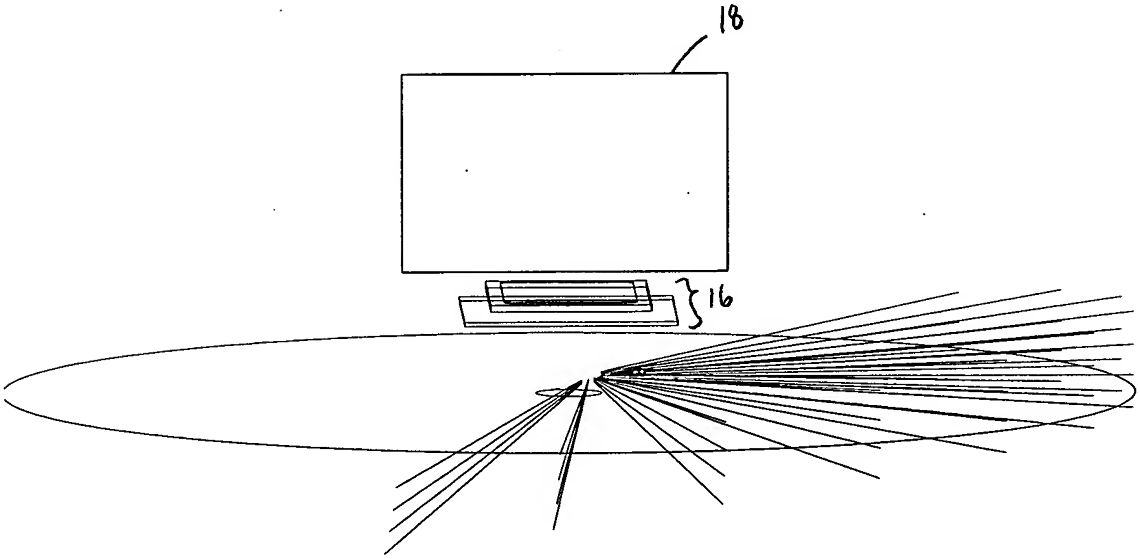


First Polygon PM1	Second Polygon PM2
$\beta_1 = 11.6°$	$\beta_1 = 10°$
$\beta_2 = 13.3°$	$\beta_2 = 12°$
$\beta_3 = 14.9°$	$\beta_3 = -10°$
$\beta_4 = 16.6°$	$\beta_4 = -12°$

FIG. 2G1

10045905.071102

FIG. 262



10/070307.031802

10045605 .011102

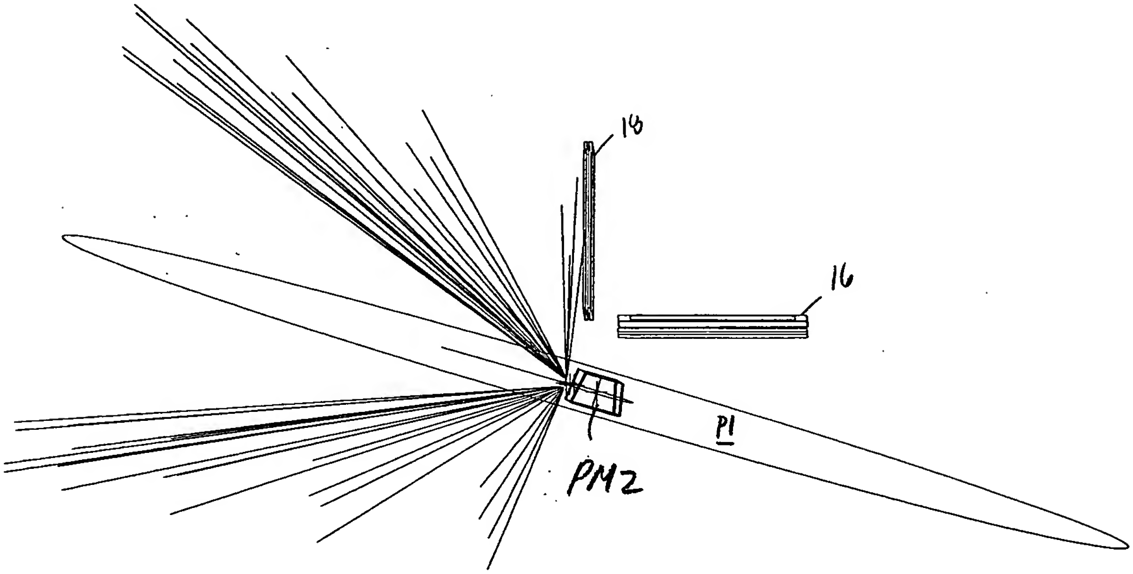


FIG. 263

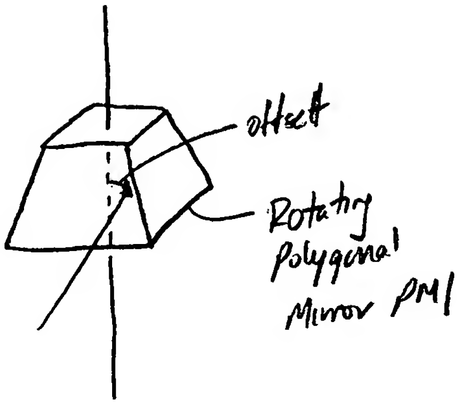
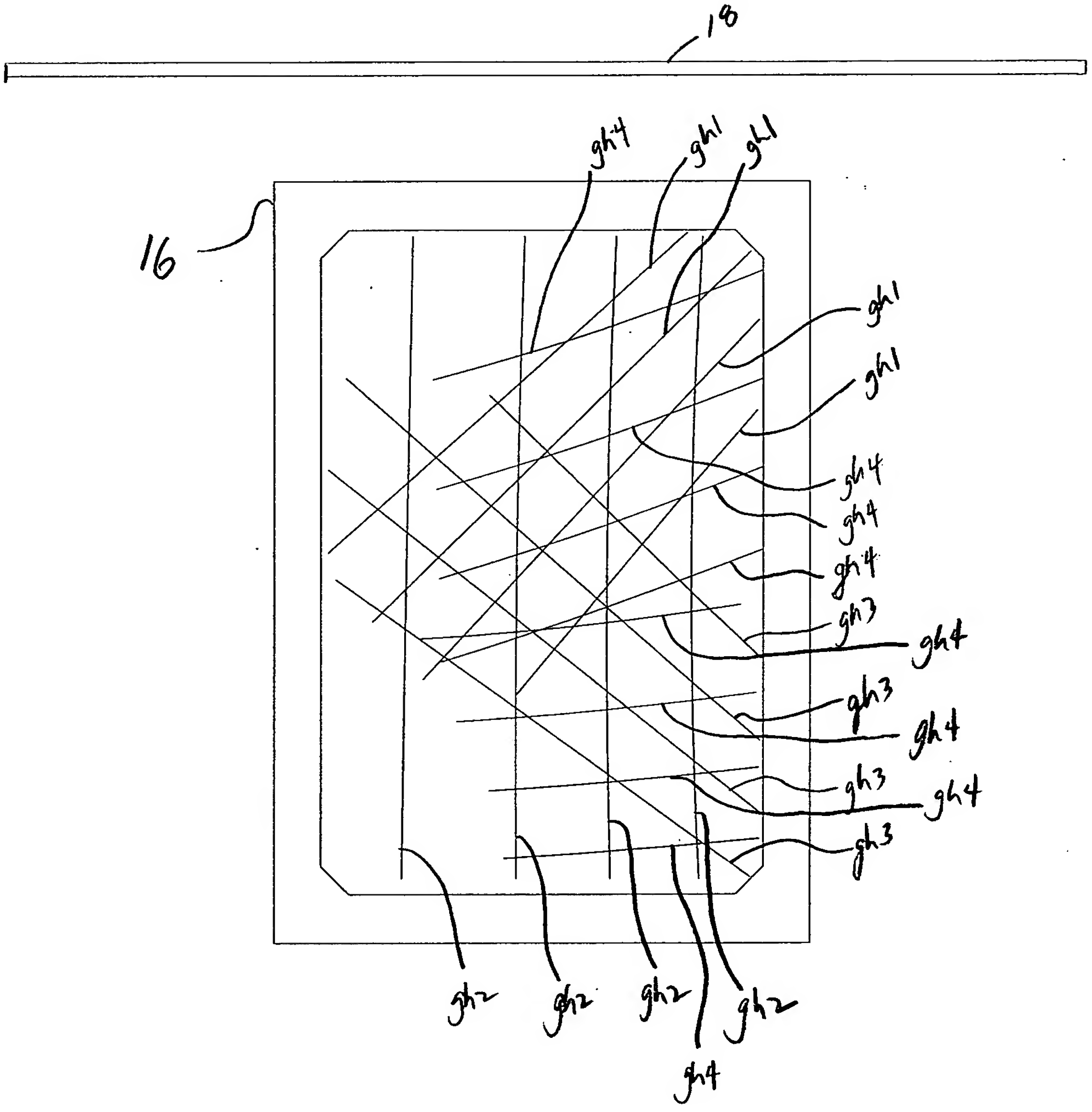

offset
Rotating Polygonal Mirror PM1

FIG. 2H

FIG. 3A


18
16
gh4
gh1
gh1
gh1
gh1
gh4
gh4
gh4
gh3
gh4
gh3
gh4
gh3
gh4
gh3
gh2
gh2
gh2
gh2
gh4

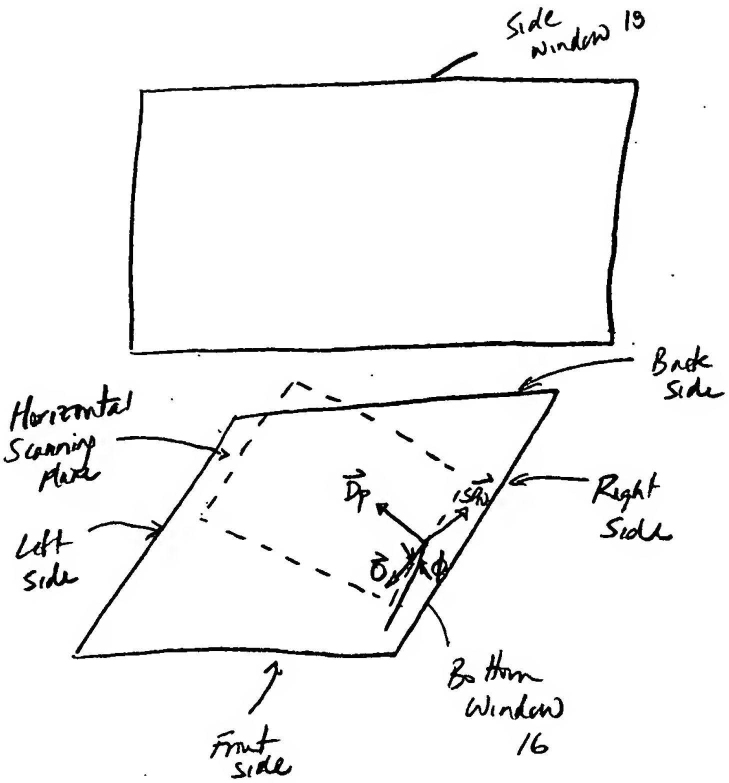

Side window 18
Back side
Horizontal Scanning Plane
$\vec{D}_p$
$\vec{SR}$
Right Side
Left side
$\vec{O}$
ϕ
Bottom Window 16
Front side

Fig. 3B1

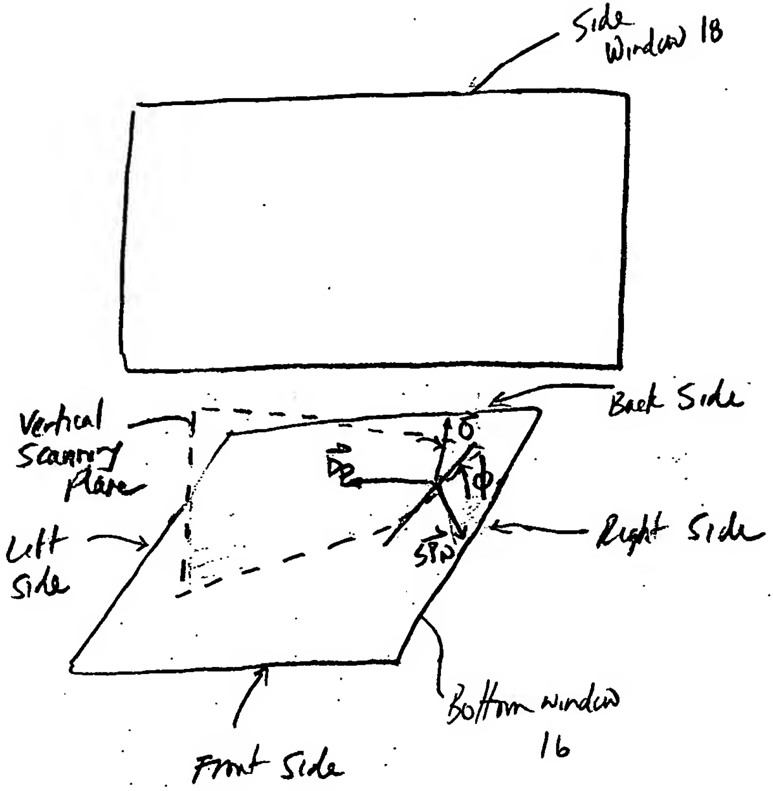

Side window 18
Back Side
Vertical Scanning Plane
$\vec{D}_P$
θ
φ
$\vec{SP}_N$
Right Side
Left Side
Bottom window 16
Front Side

FIG. 3B2

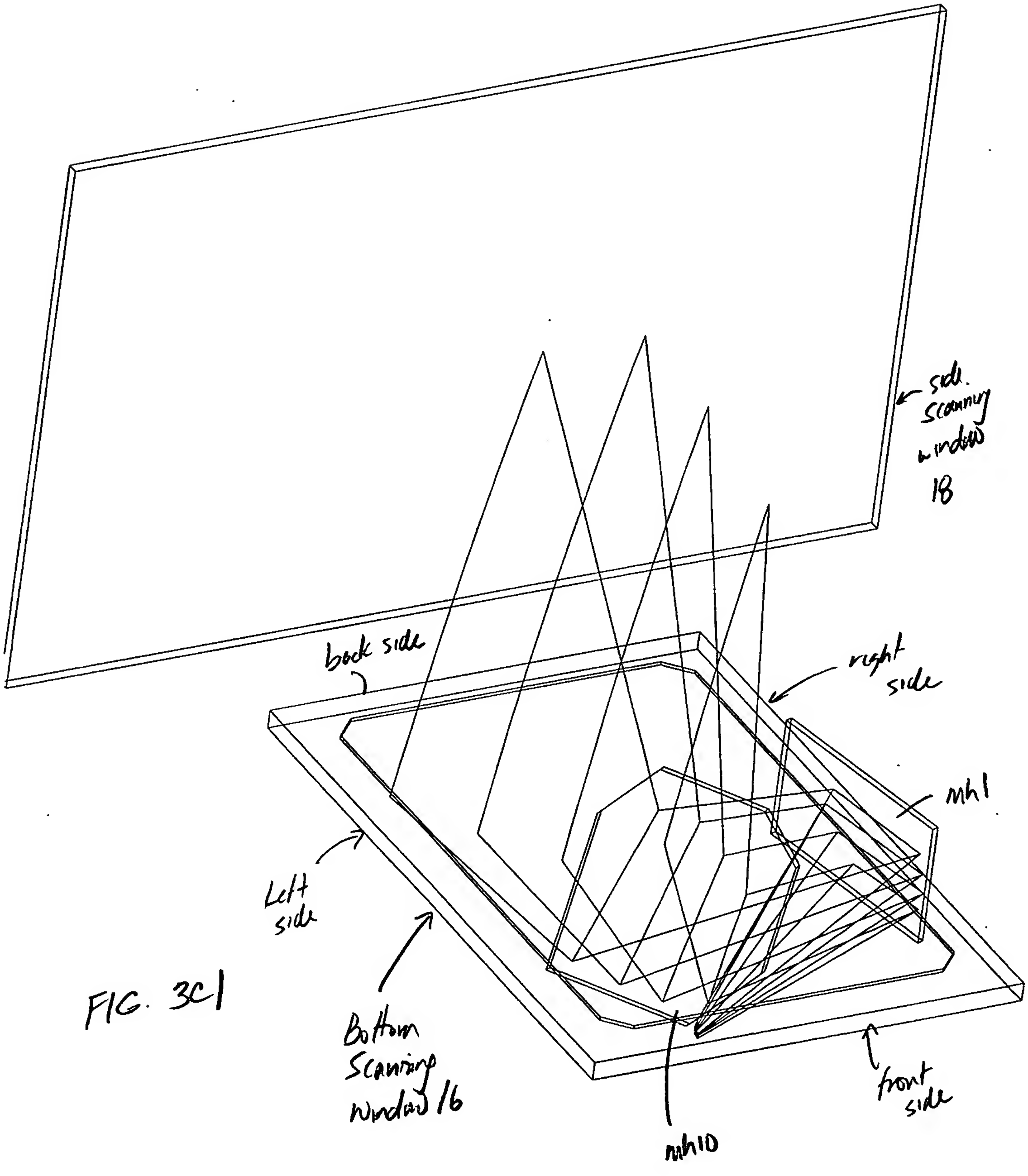
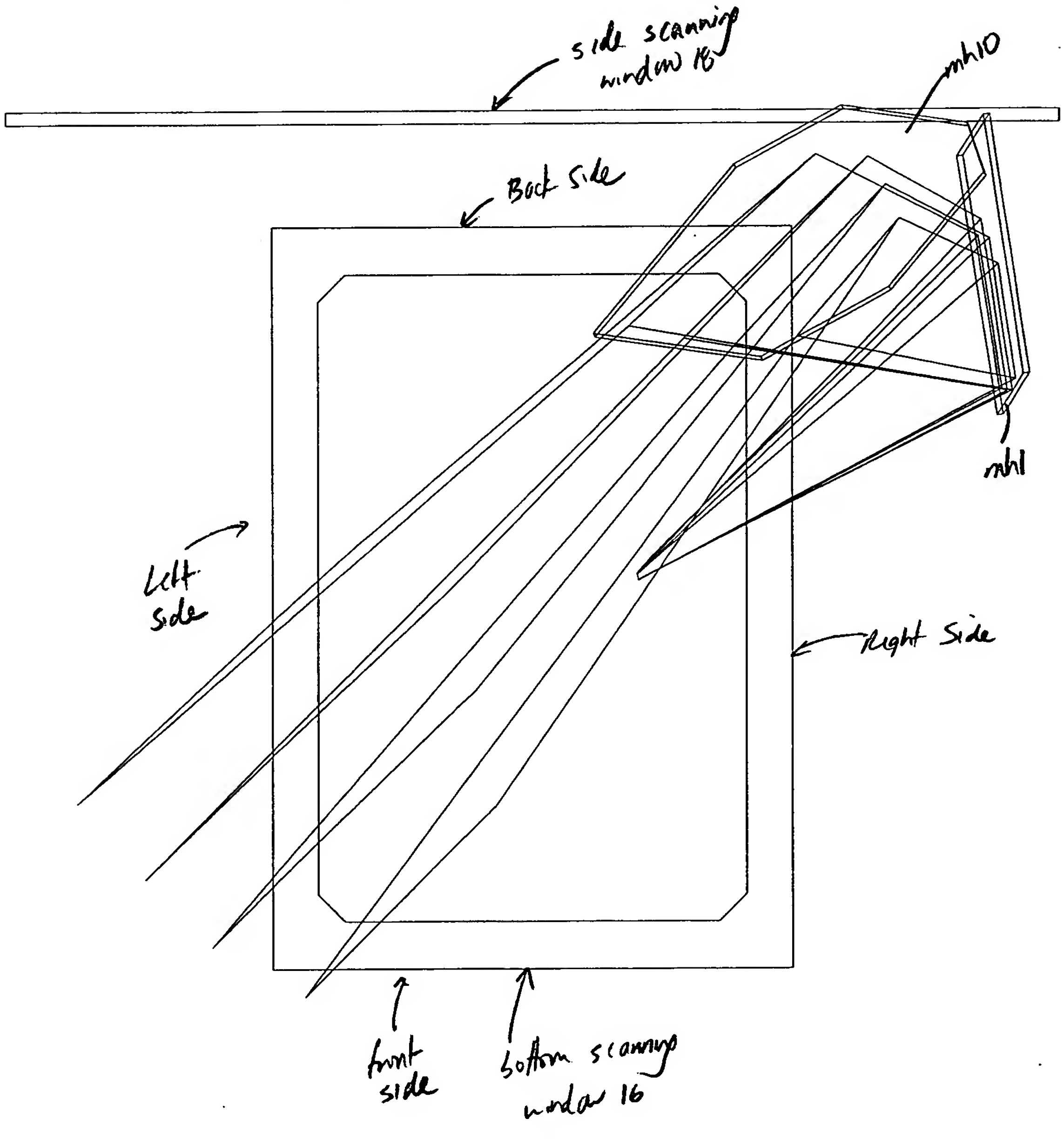

side scanning window 18
back side
right side
mh1
Left side
Bottom Scanning window 16
front side
mh10

FIG. 3C1

10045605.011102

FIG. 3C2


side scanning window 18
mh10
Back side
mh1
Left side
Right Side
front side
bottom scanning window 16

10075303 . 011703

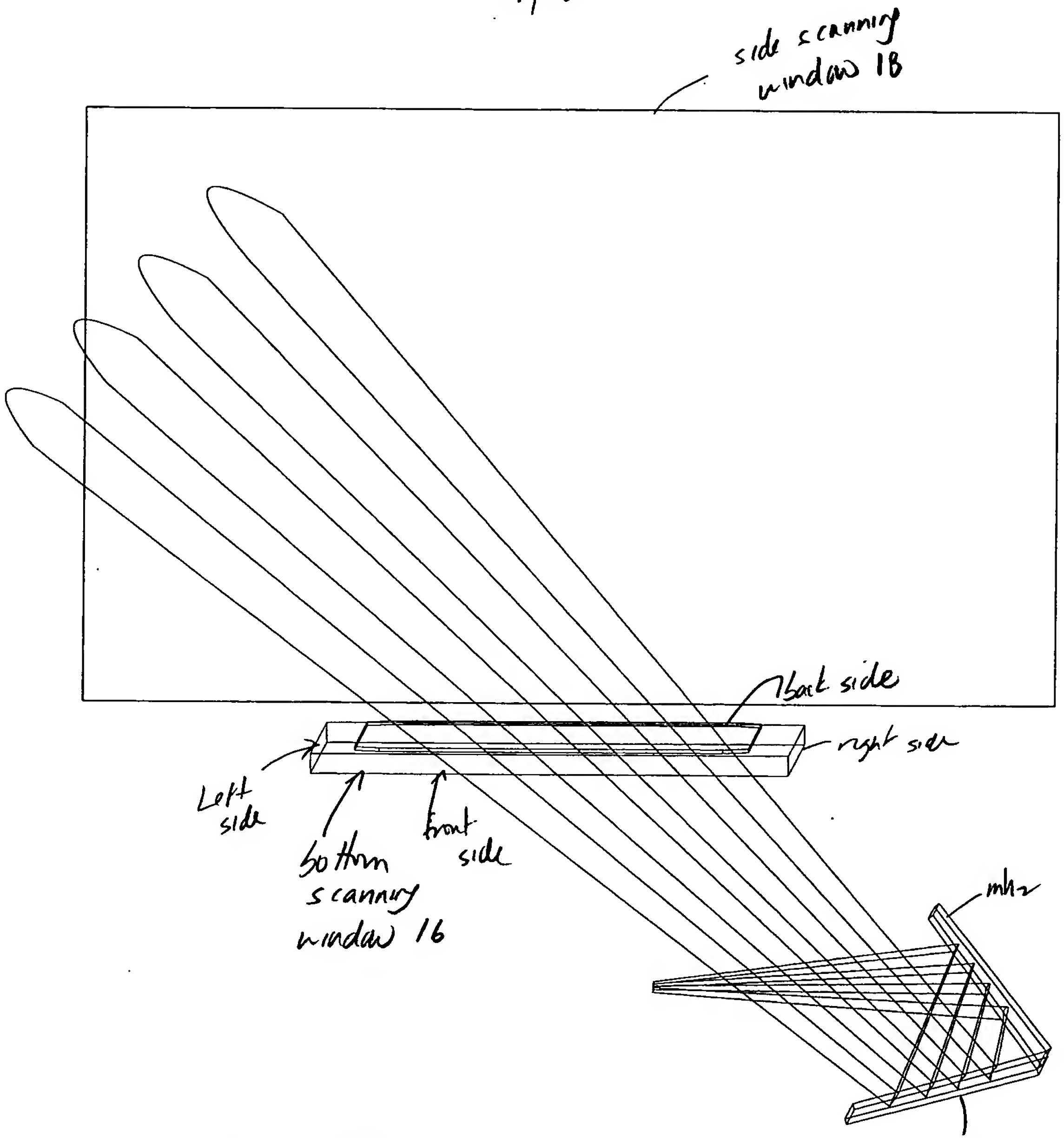

side scanning window 18
back side
right side
Left side
bottom scanning window 16
front side
mh2
mh11

FIG 3D1

10045605.011102

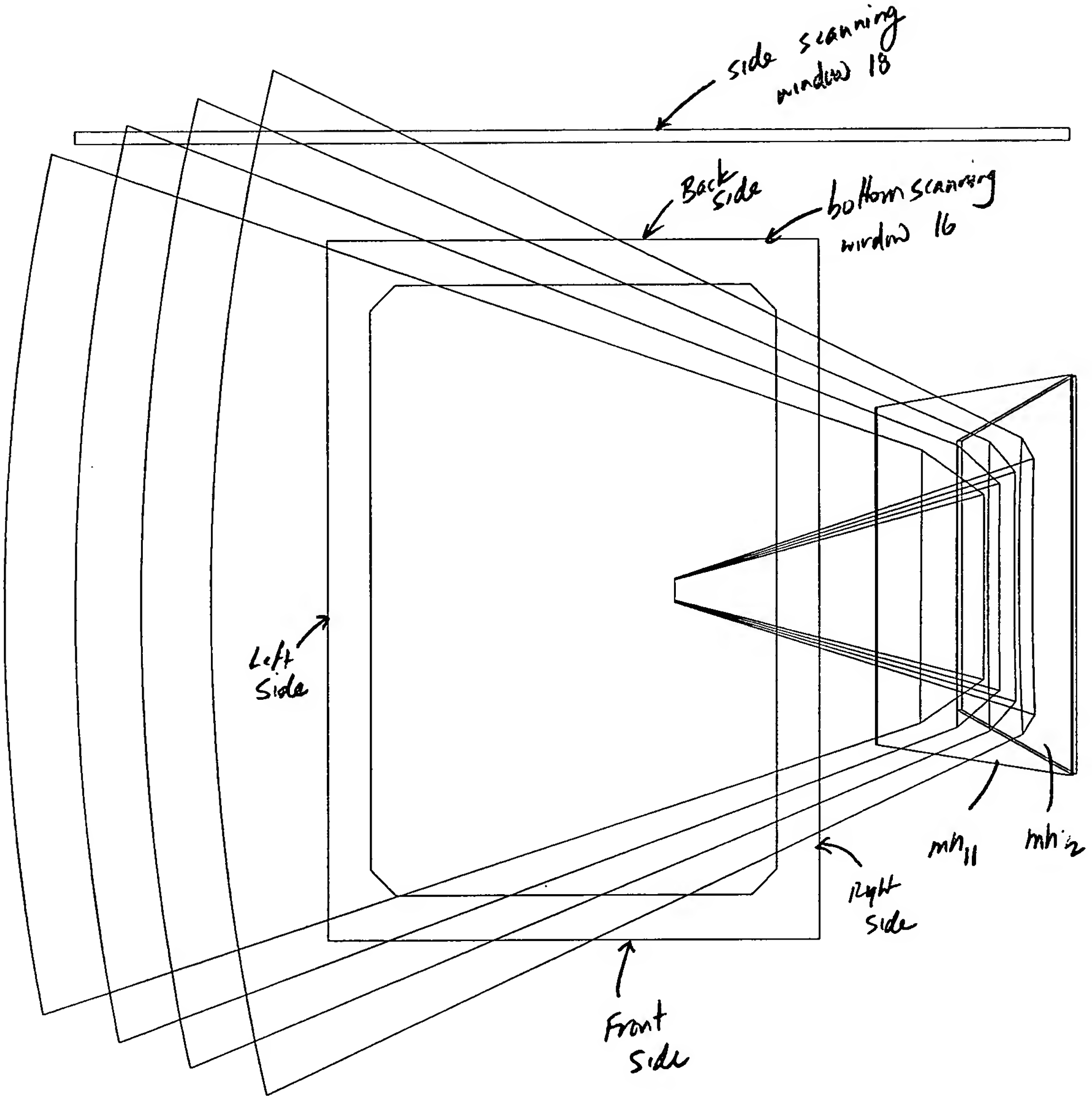

side scanning window 18
Back side
bottom scanning window 16
Left Side
Right side
Front side
mh11
mh12

FIG. 3D2

10045605 .011102

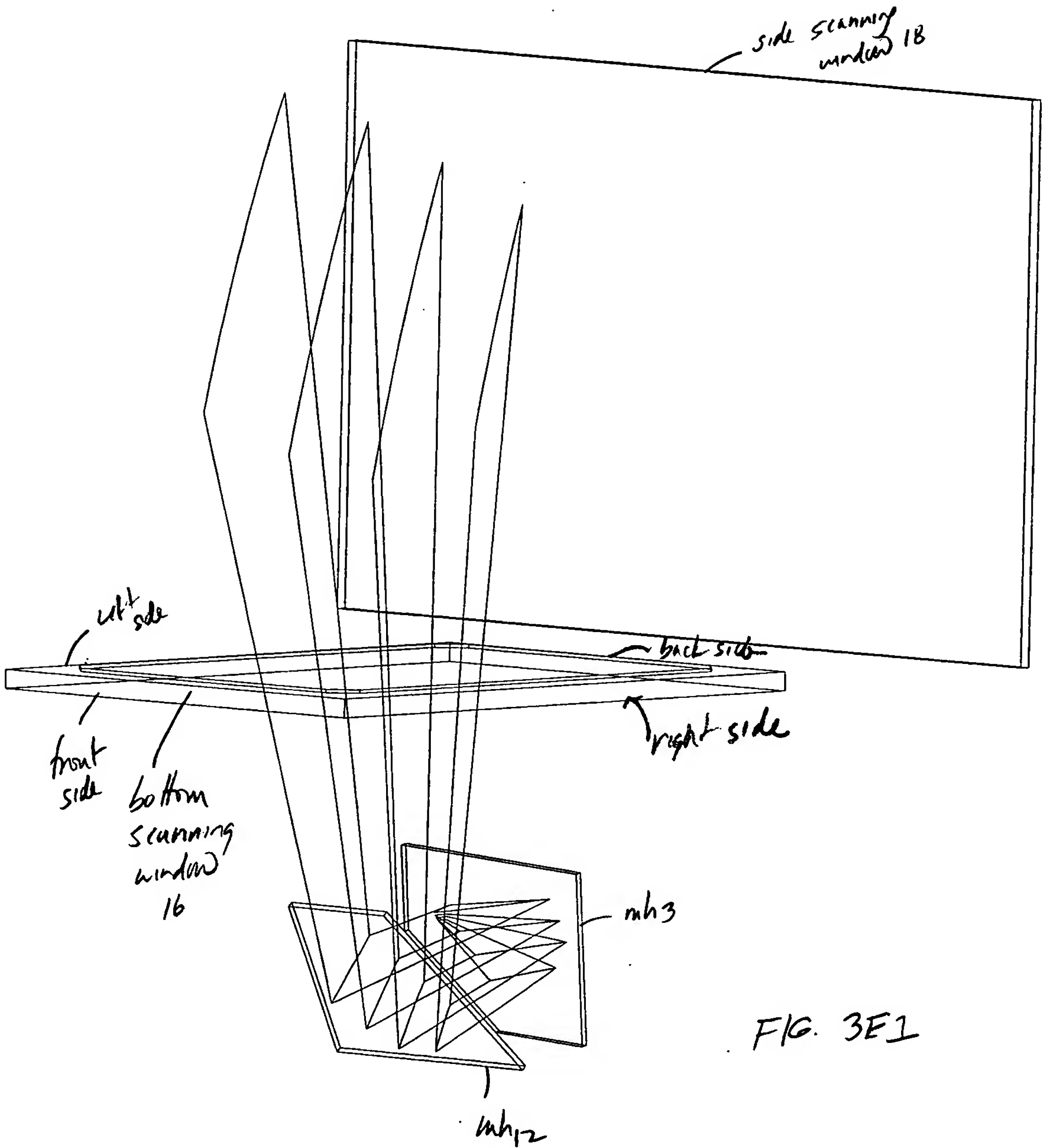

side scanning window 18
left side
back side
right side
front side
bottom scanning window 16
mh3
mh12

FIG. 3E1

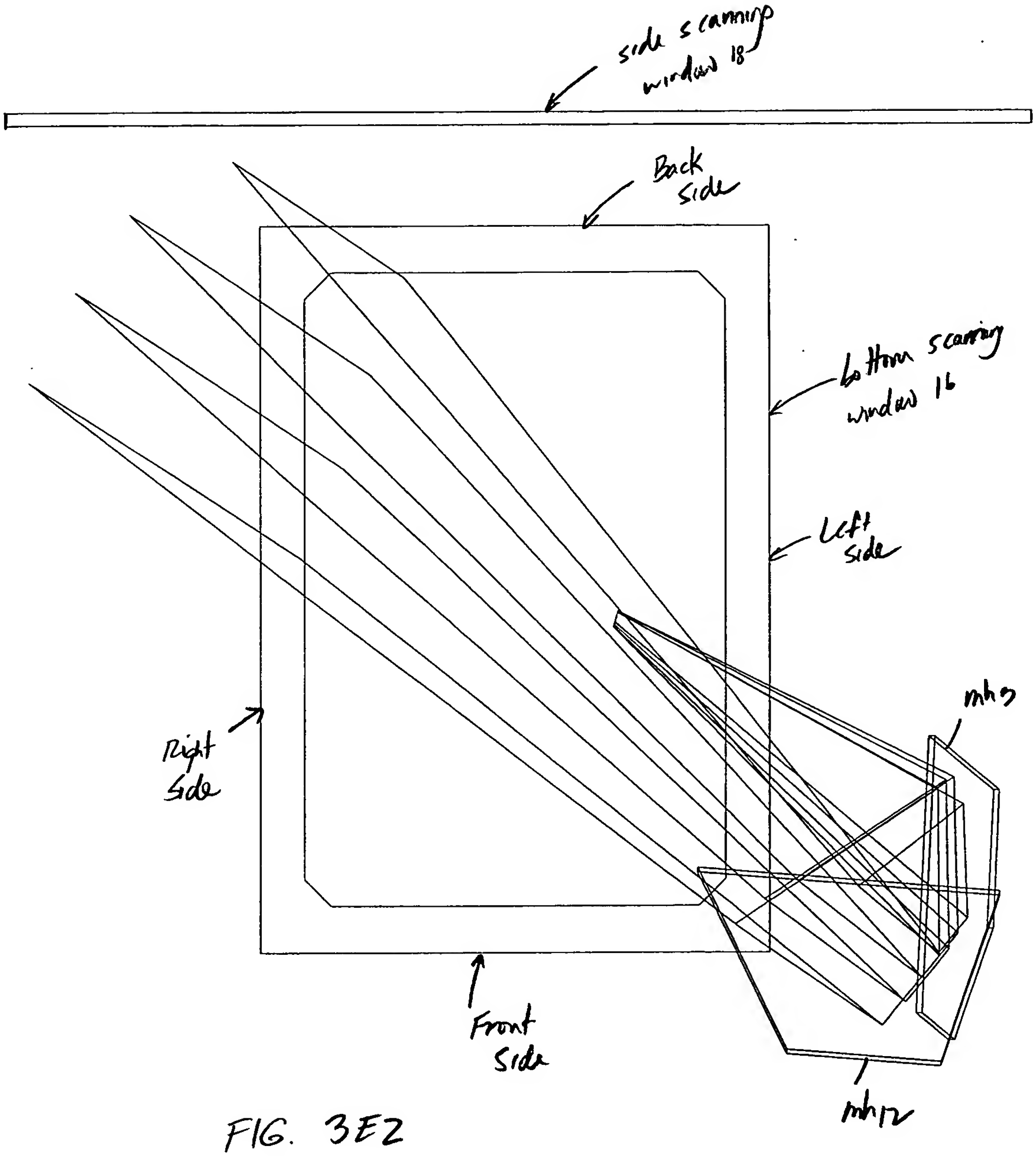

side scanning window 18
Back side
bottom scanning window 16
Left side
Right side
Front side
mh9
mh12

FIG. 3E2

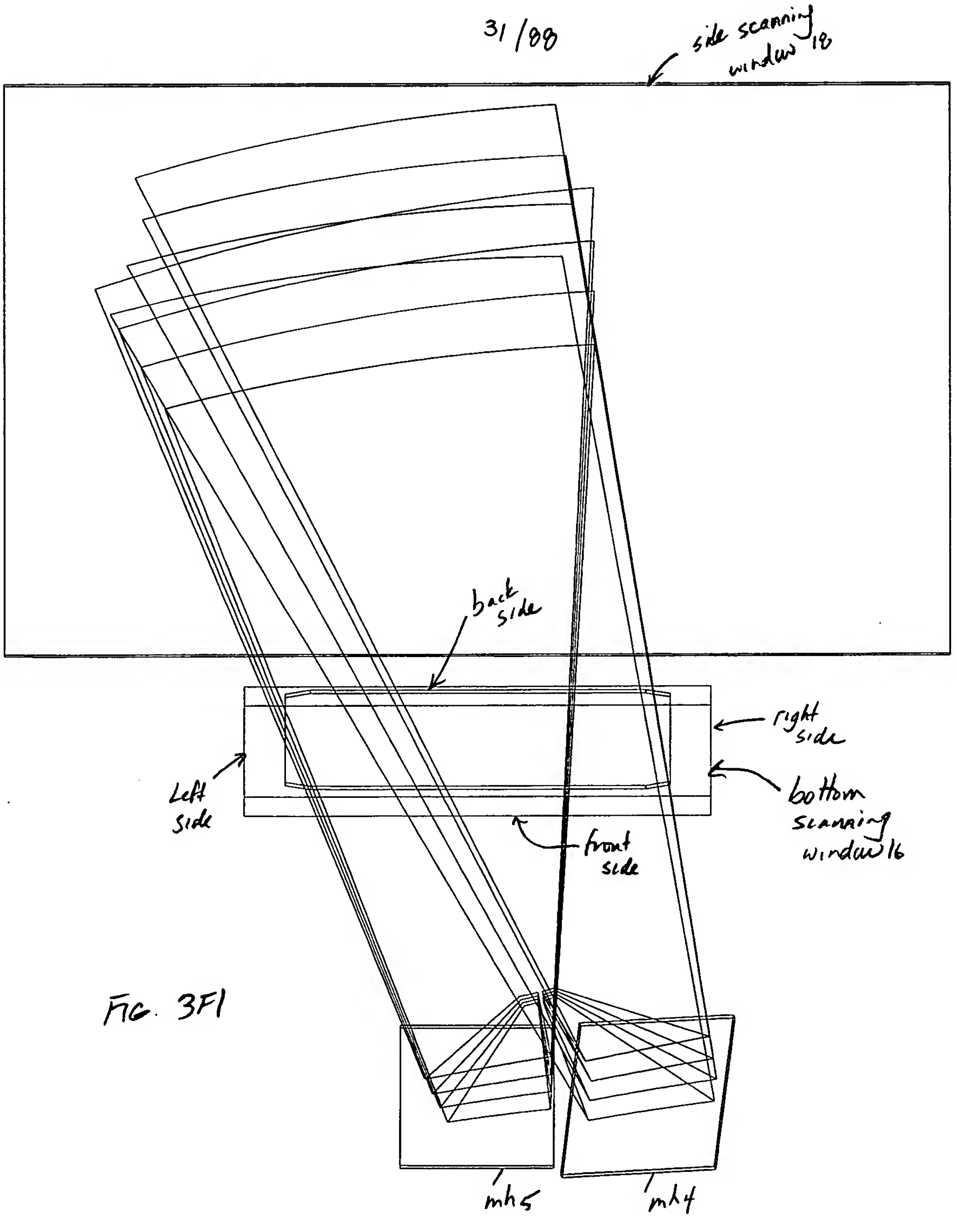

side scanning window 18
back side
right side
bottom scanning window 16
Left side
front side
mh5
mh4

FIG. 3F1

10045305 .011702

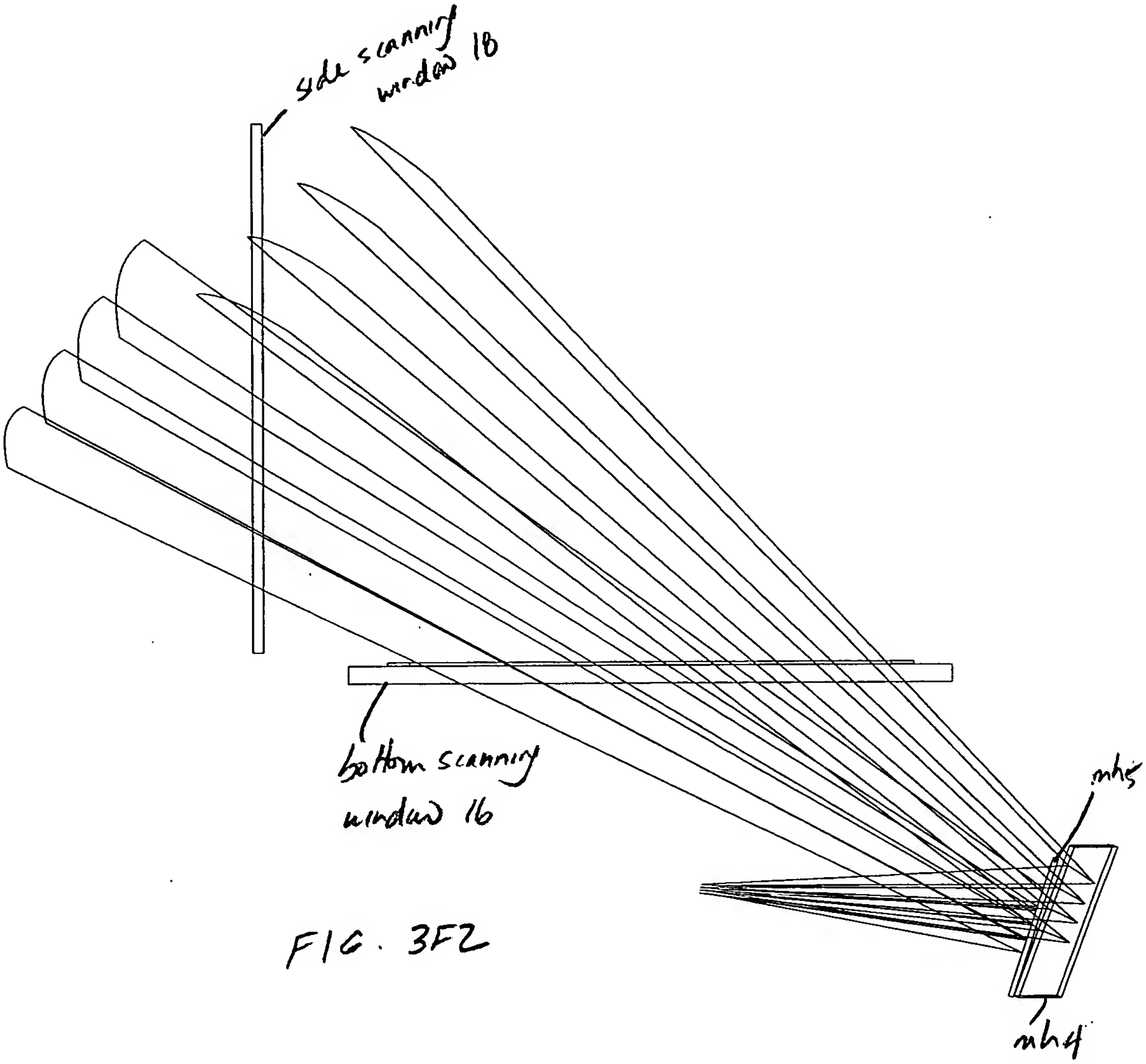
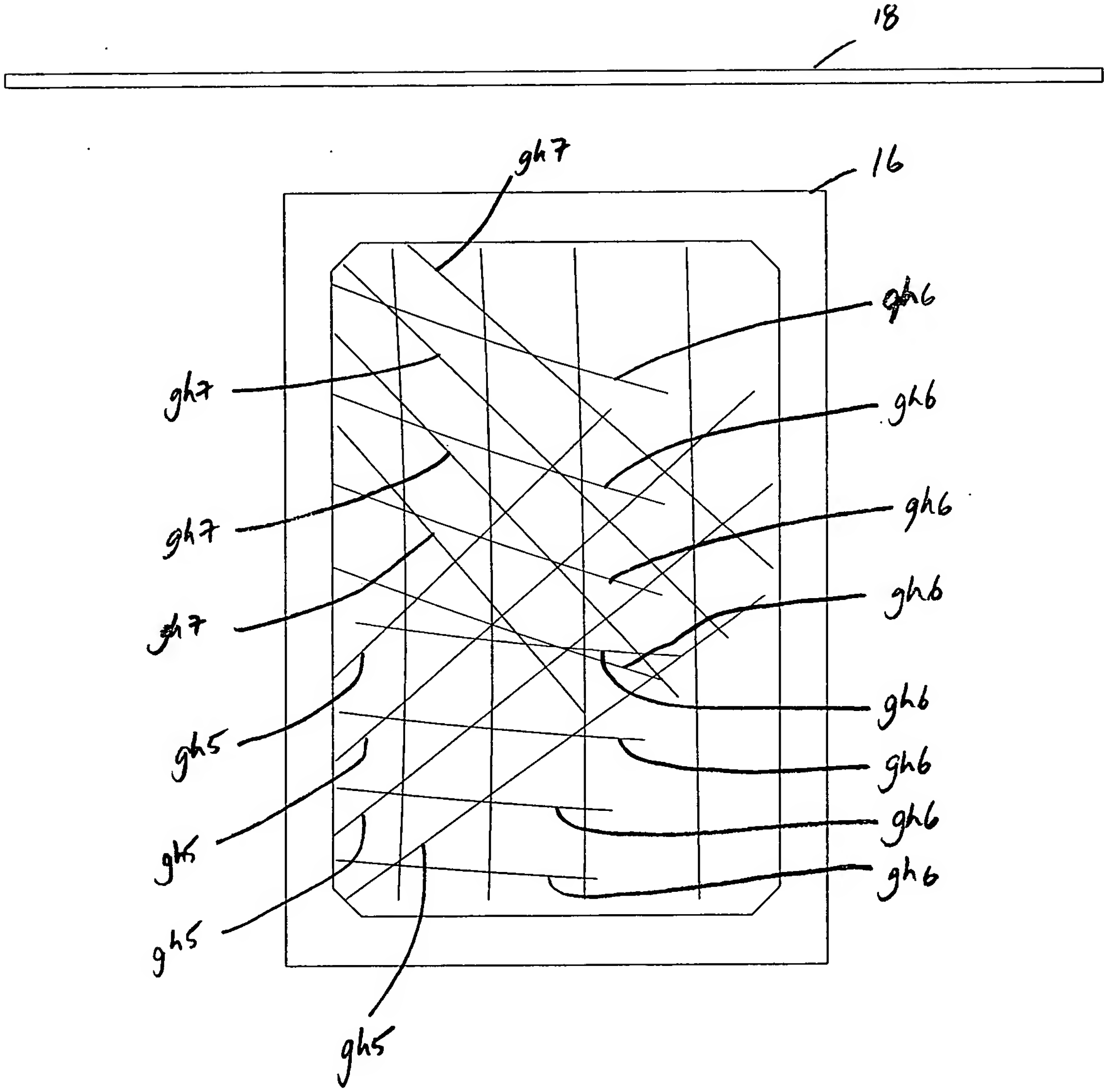

side scanning window 18
bottom scanning window 16
mh5
mh4

FIG. 3F2

FIG. 4A


18
16
gh7
gh7
gh7
gh7
gh5
gh5
gh5
gh5
gh6
gh6
gh6
gh6
gh6
gh6
gh6
gh6

30775968.071001

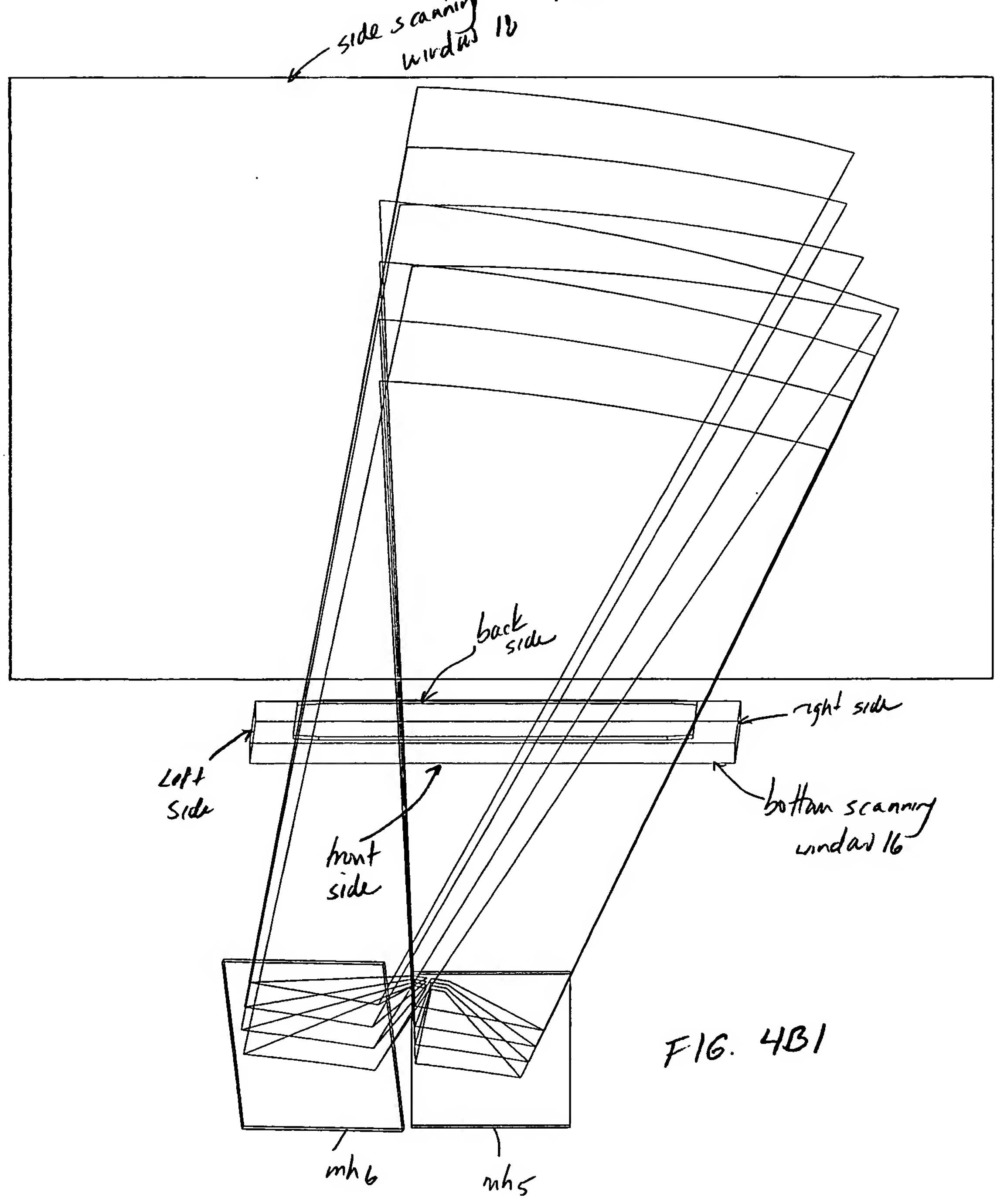

side scanning window 18
back side
right side
left side
bottom scanning window 16
front side
mh6
mh5

FIG. 4B1

10045505 .011102

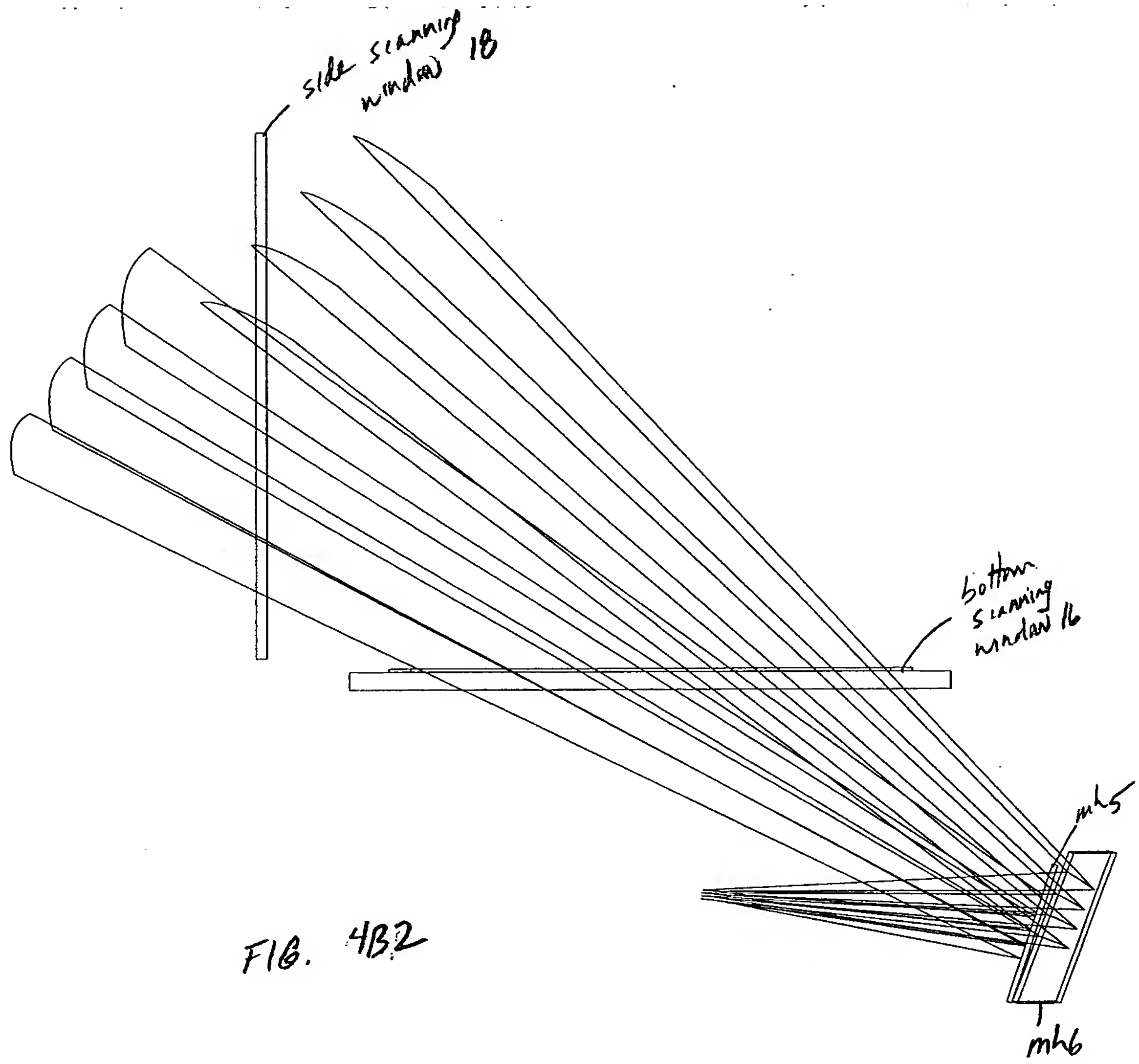

side scanning window 18
bottom scanning window 16
mh5
mh6

FIG. 4B2

FIG. 4C1

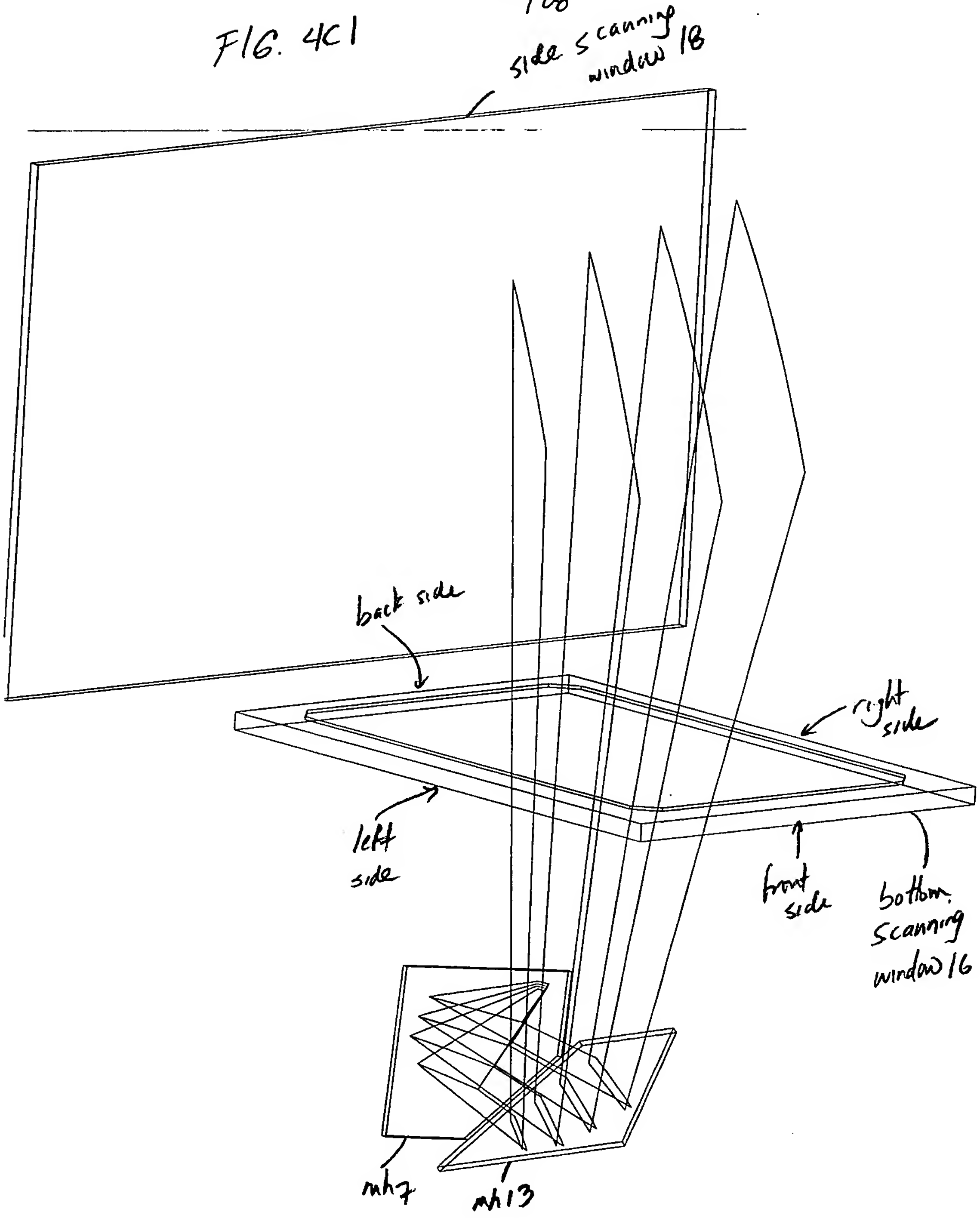
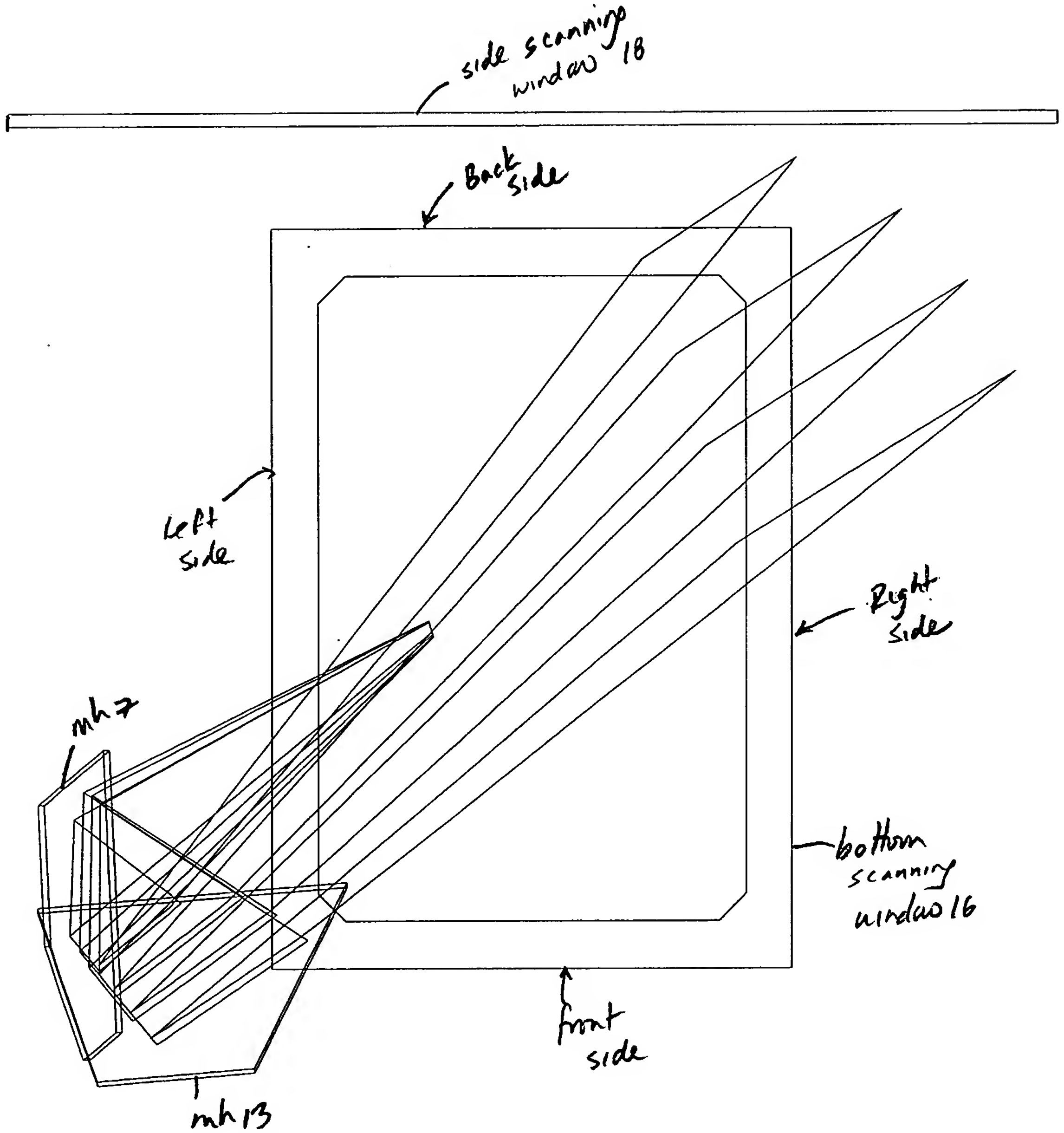

side scanning window 18
back side
right side
left side
front side
bottom scanning window 16
mh7
mh13

FIG. 4C2


side scanning window 18
Back side
left side
Right side
bottom scanning window 16
front side
mh7
mh13

10045605 .011102

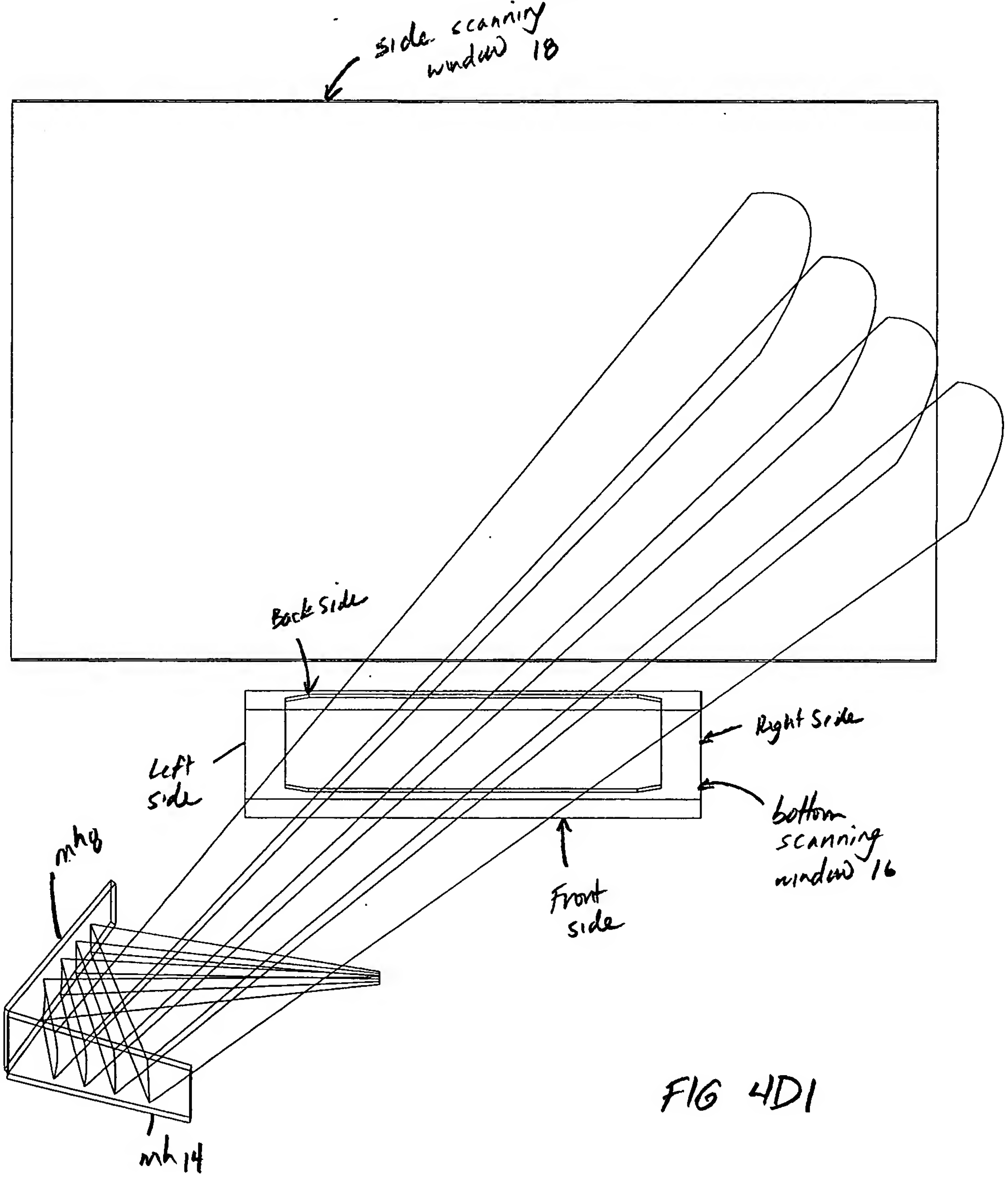

side scanning window 18
Back side
Right side
Left side
bottom scanning window 16
Front side
mh8
mh14

FIG 4D1

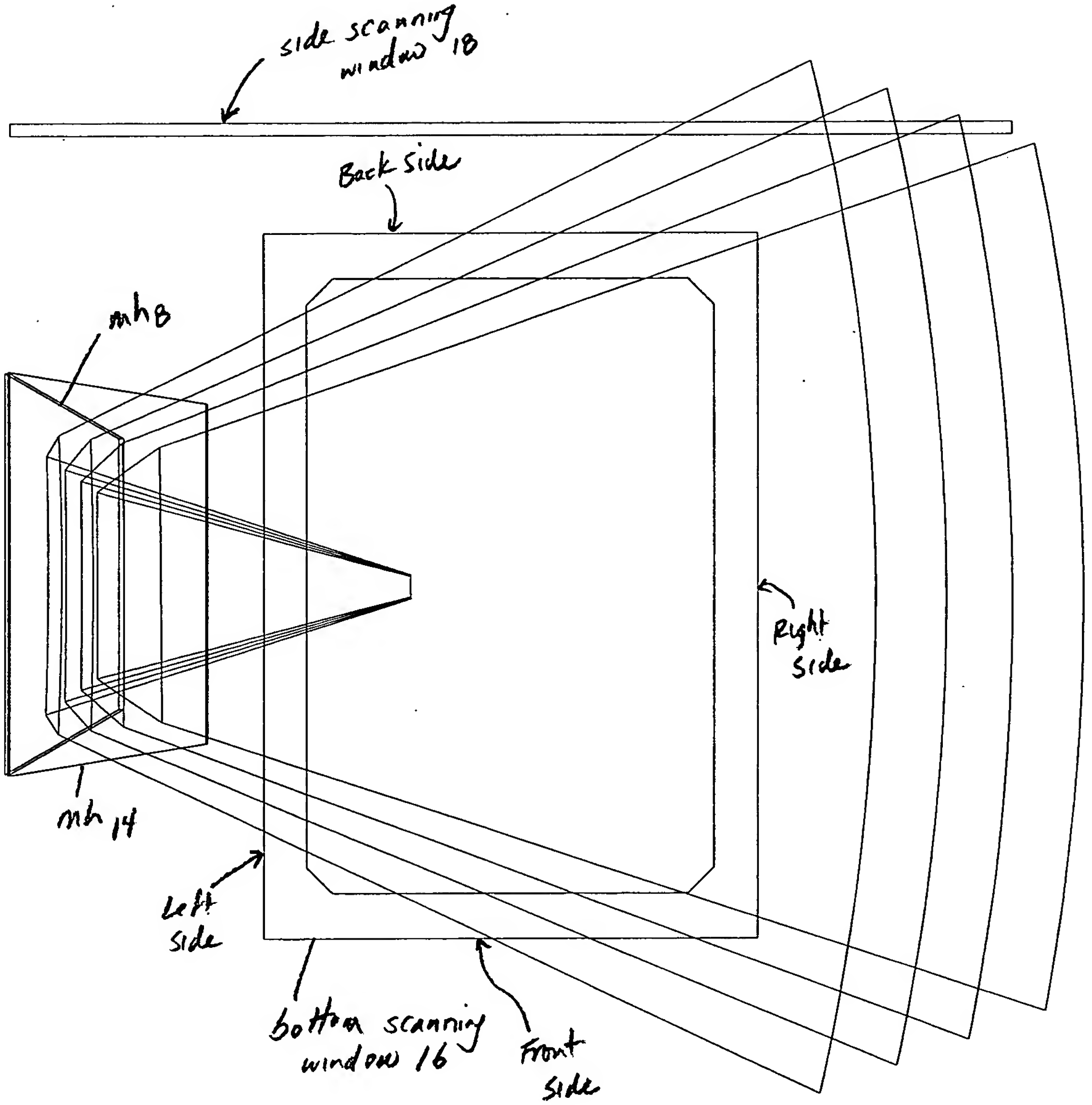

side scanning window 18
Back side
mh8
Right side
mh 14
left side
bottom scanning window 16
Front side

FIG. 4D2

10045605 .011102

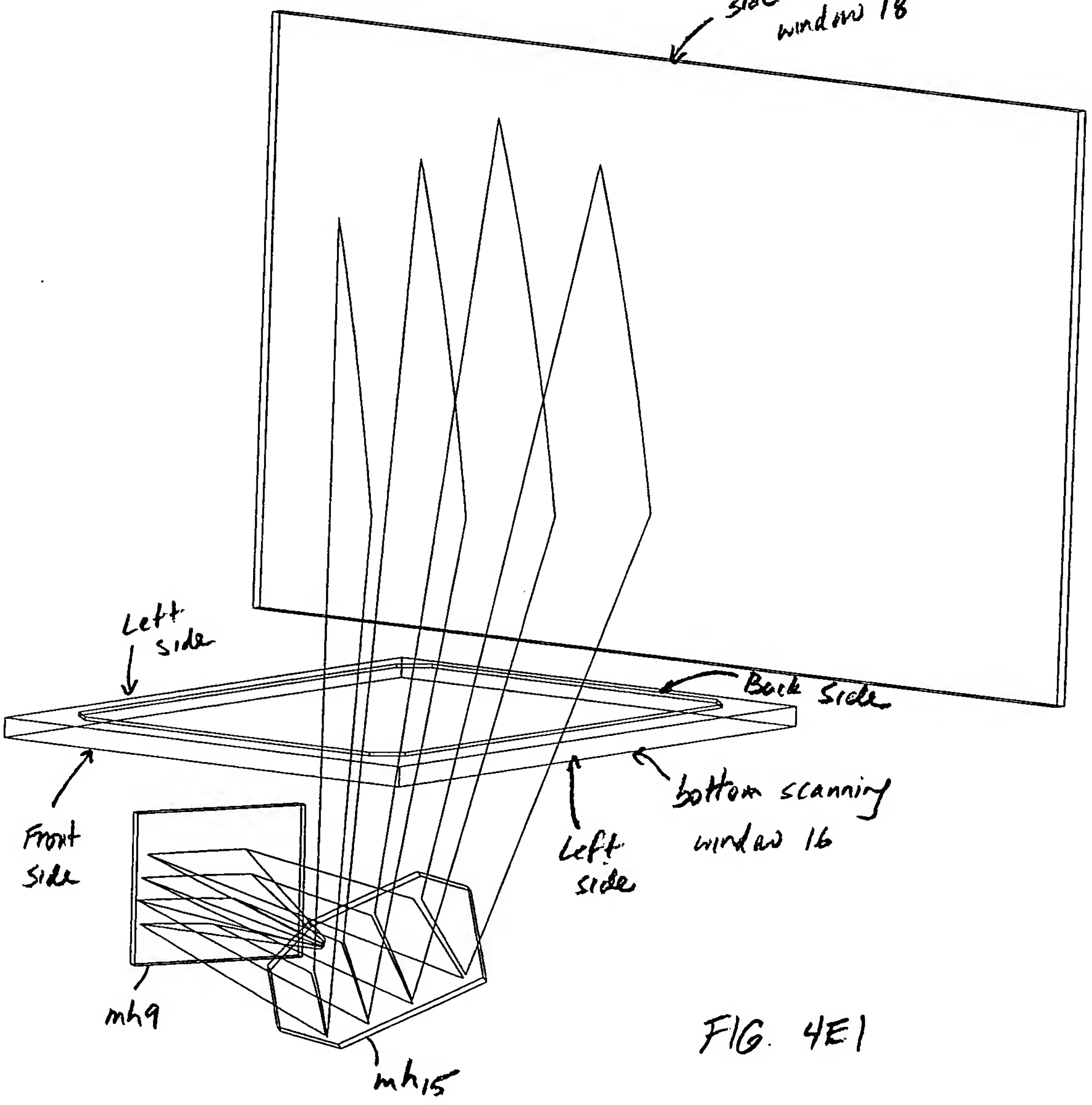

side scanning window 18
Left side
Back side
Front side
bottom scanning window 16
Left side
mh9
mh15

FIG. 4E1

FIG. 4E2

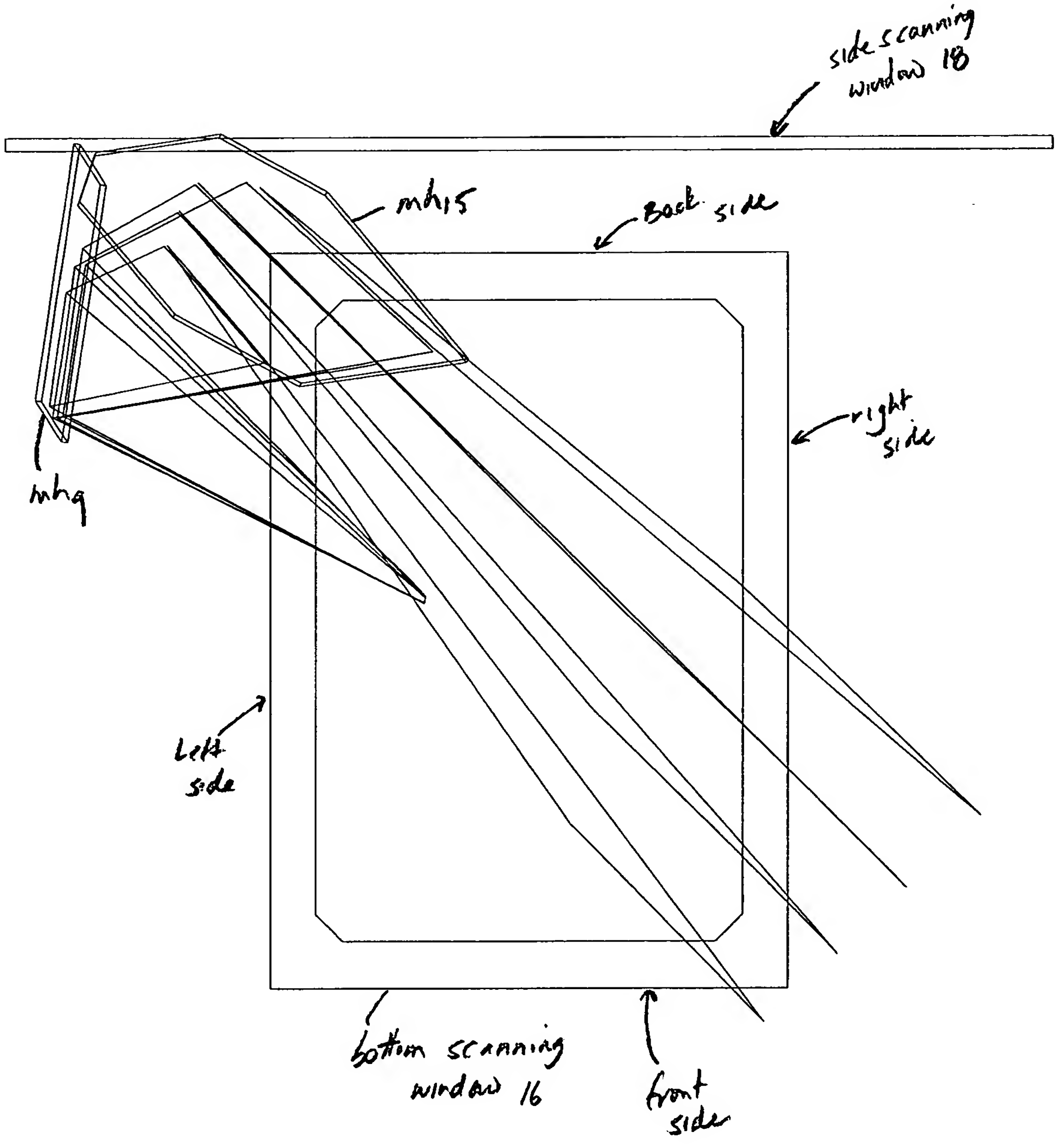
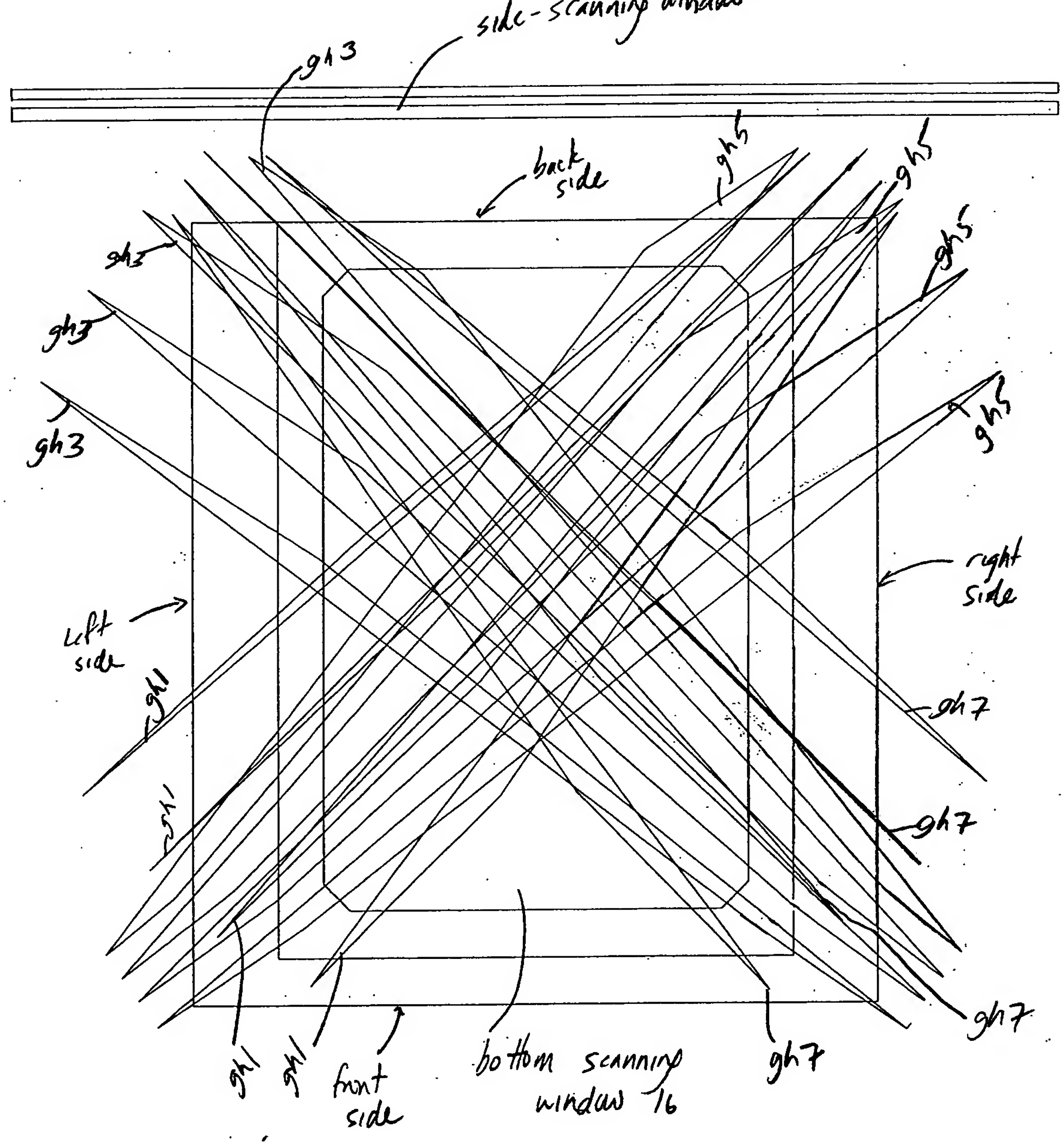

side scanning window 18
mh15
Back side
right side
mh9
Left side
bottom scanning window 16
front side

FIG. 4F


side-scanning window 18
gh3
back side
gh5
gh5
gh5
gh5
gh3
gh3
gh3
left side
gh1
gh1
right side
gh7
gh7
gh7
gh7
gh1
gh1
front side
bottom scanning window 16

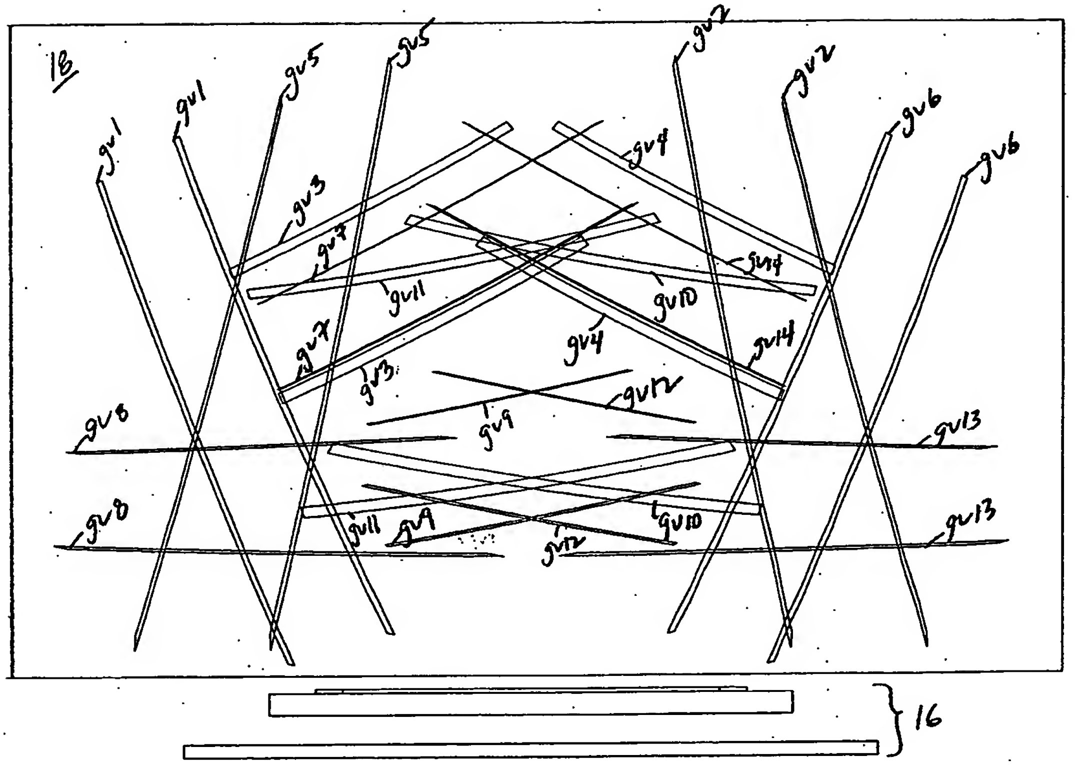

18
gv1
gv1
gv5
gv5
gv2
gv2
gv6
gv6
gv4
gv3
gv7
gv14
gv11
gv10
gv7
gv4
gv14
gv3
gv12
gv9
gv8
gv13
gv11
gv9
gv12
gv10
gv8
gv13
16

FIG. 5A

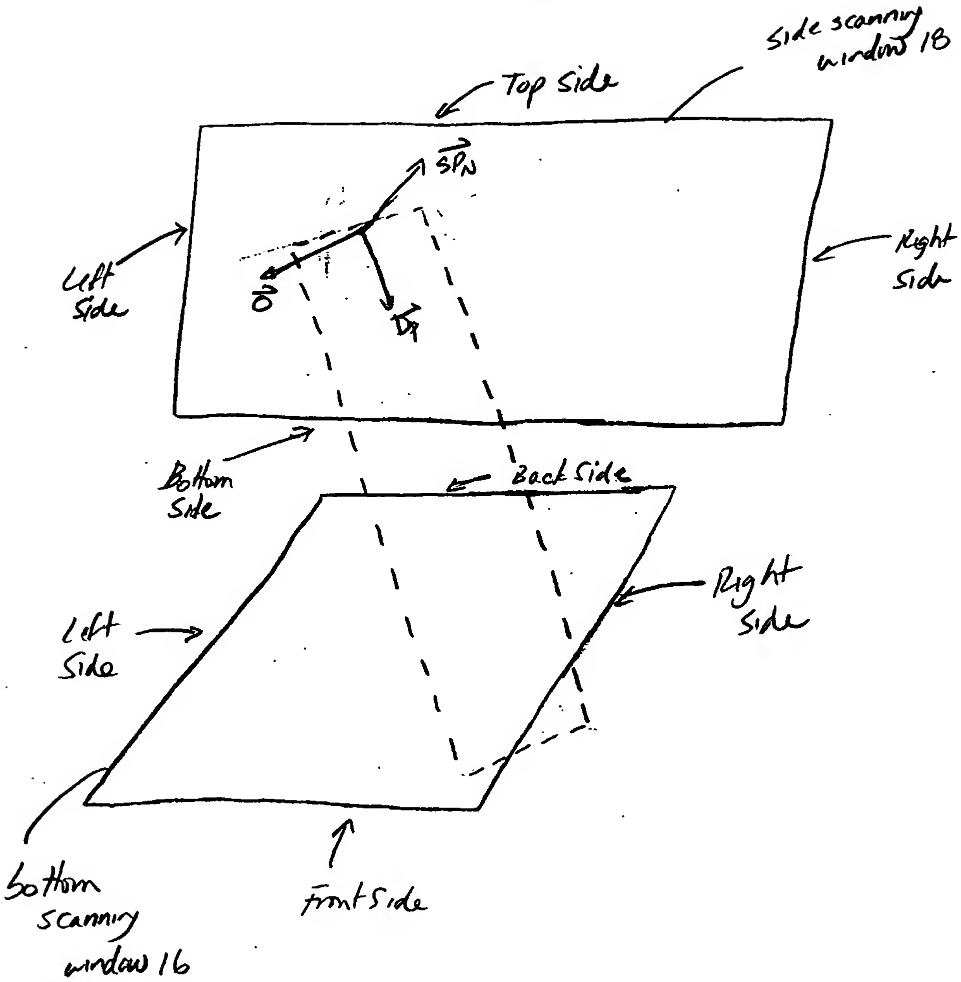

Side scanning window 18
Top side
$\vec{SP_N}$
Left Side
Right Side
$\vec{O}$
$\vec{D_R}$
Bottom Side
Back Side
Left Side
Right Side
Bottom scanning window 16
Front Side

FIG. 5B1

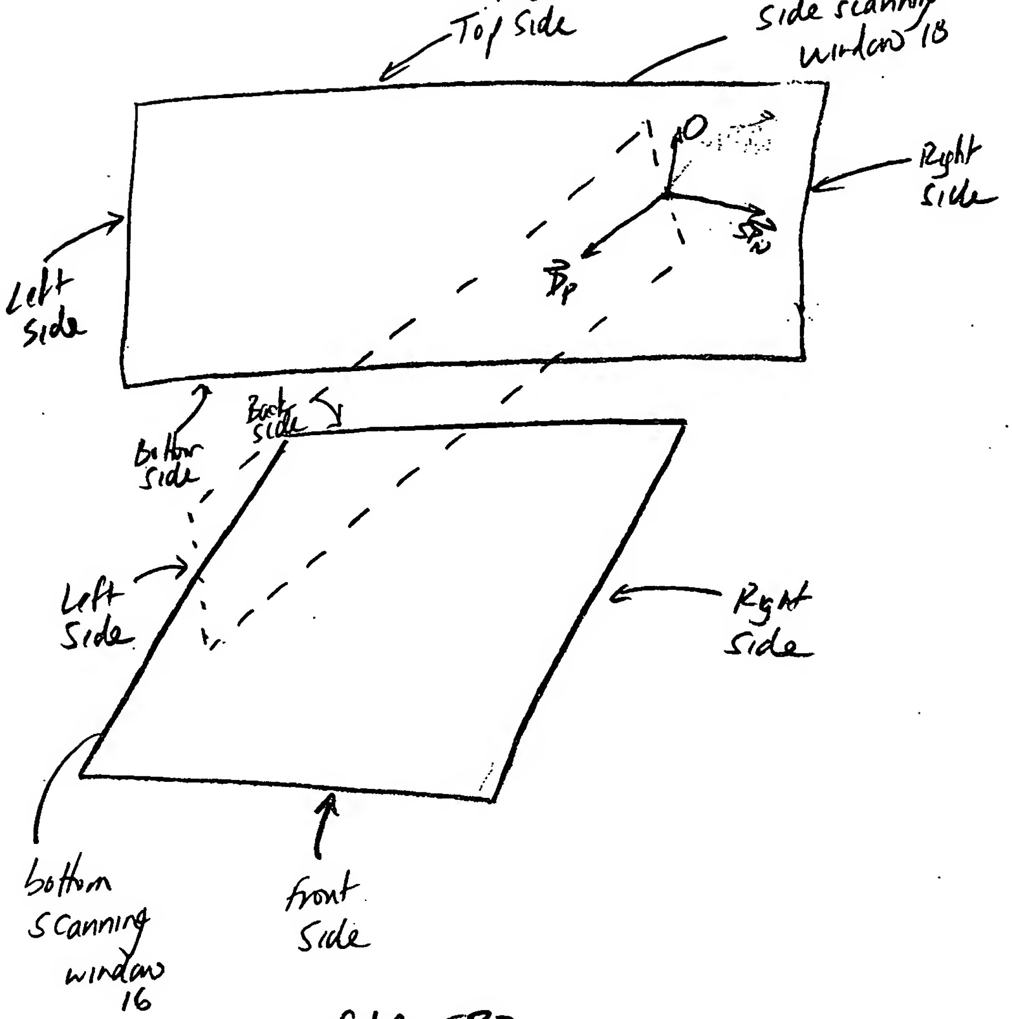

Top Side
Side scanning window 18
Left side
Right side
$\vec{D}_p$
$\vec{S}_N$
O
Bottom side
Back side
Left side
Right side
bottom scanning window 16
front side

FIG. 5B2

10045805.071102

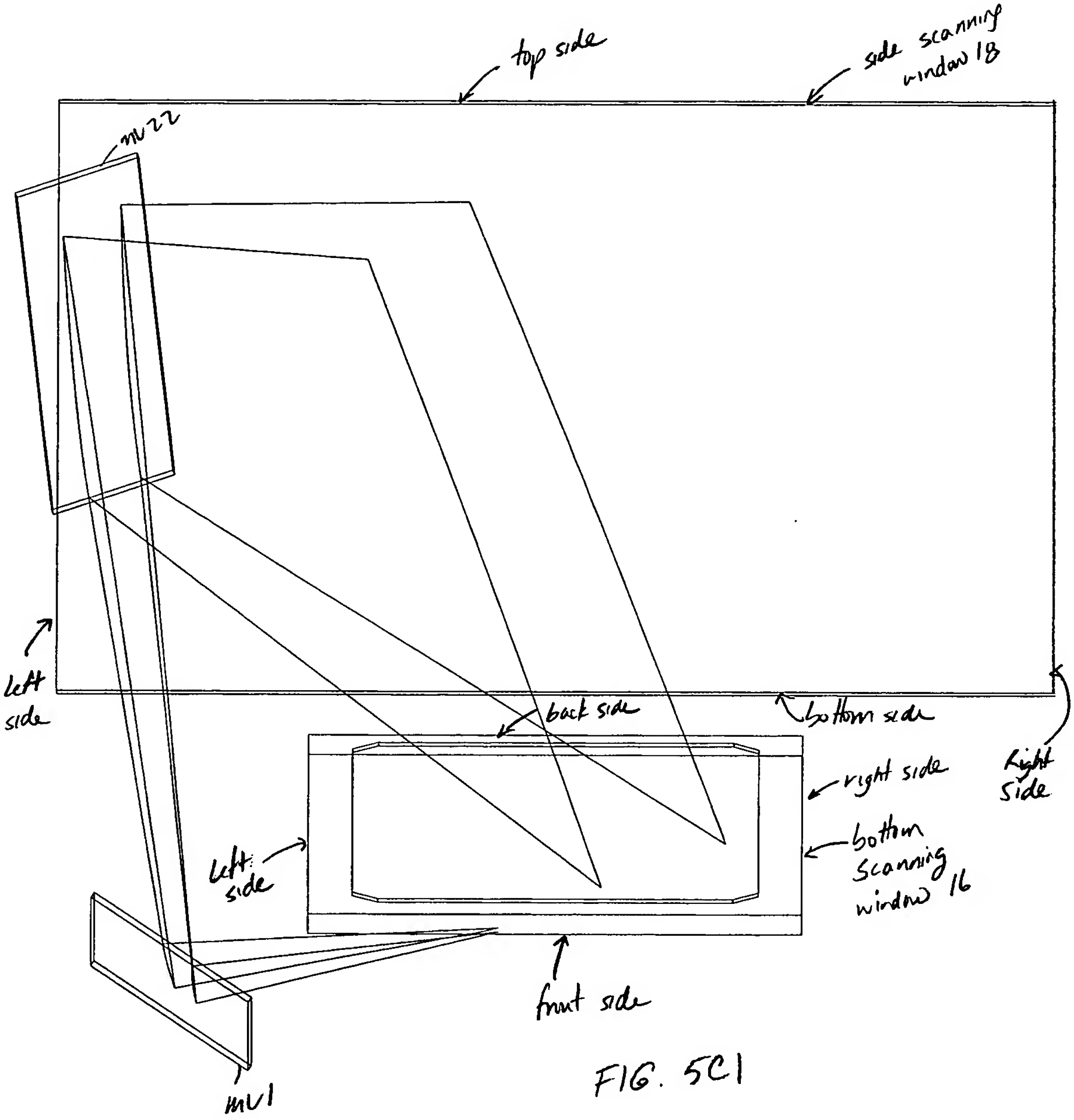

top side
side scanning window 18
mv22
left side
back side
bottom side
Right side
right side
bottom scanning window 16
left side
front side
mv1

FIG. 5C1

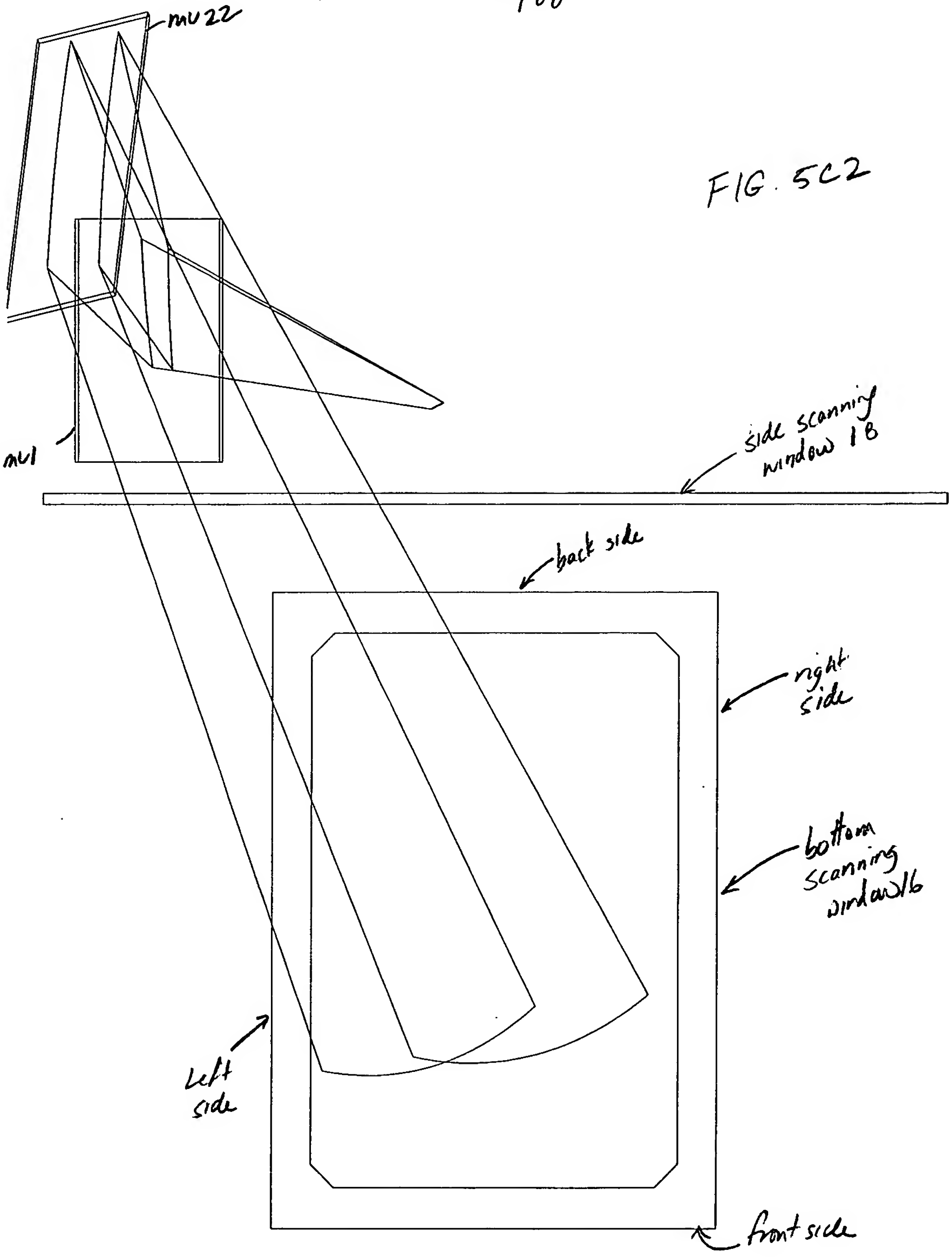

mv22
mv1
side scanning window 18
back side
right side
bottom scanning window 16
left side
front side

FIG. 5C2

10045505.011402

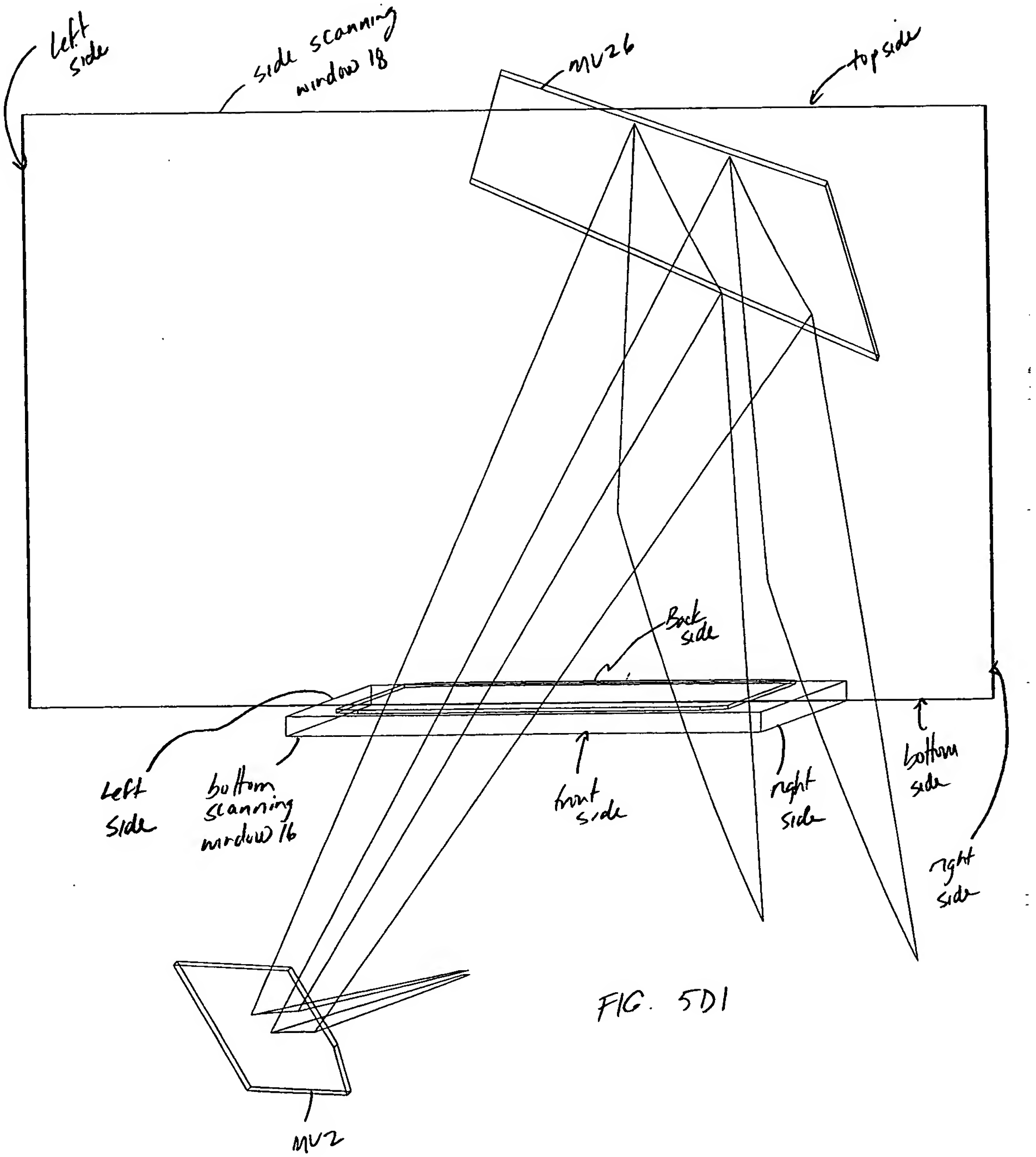

left side
side scanning window 18
MV26
top side
Back side
Left side
bottom scanning window 16
front side
right side
bottom side
right side
MV2

FIG. 5D1

10045605 .011102

FIG. 5D2

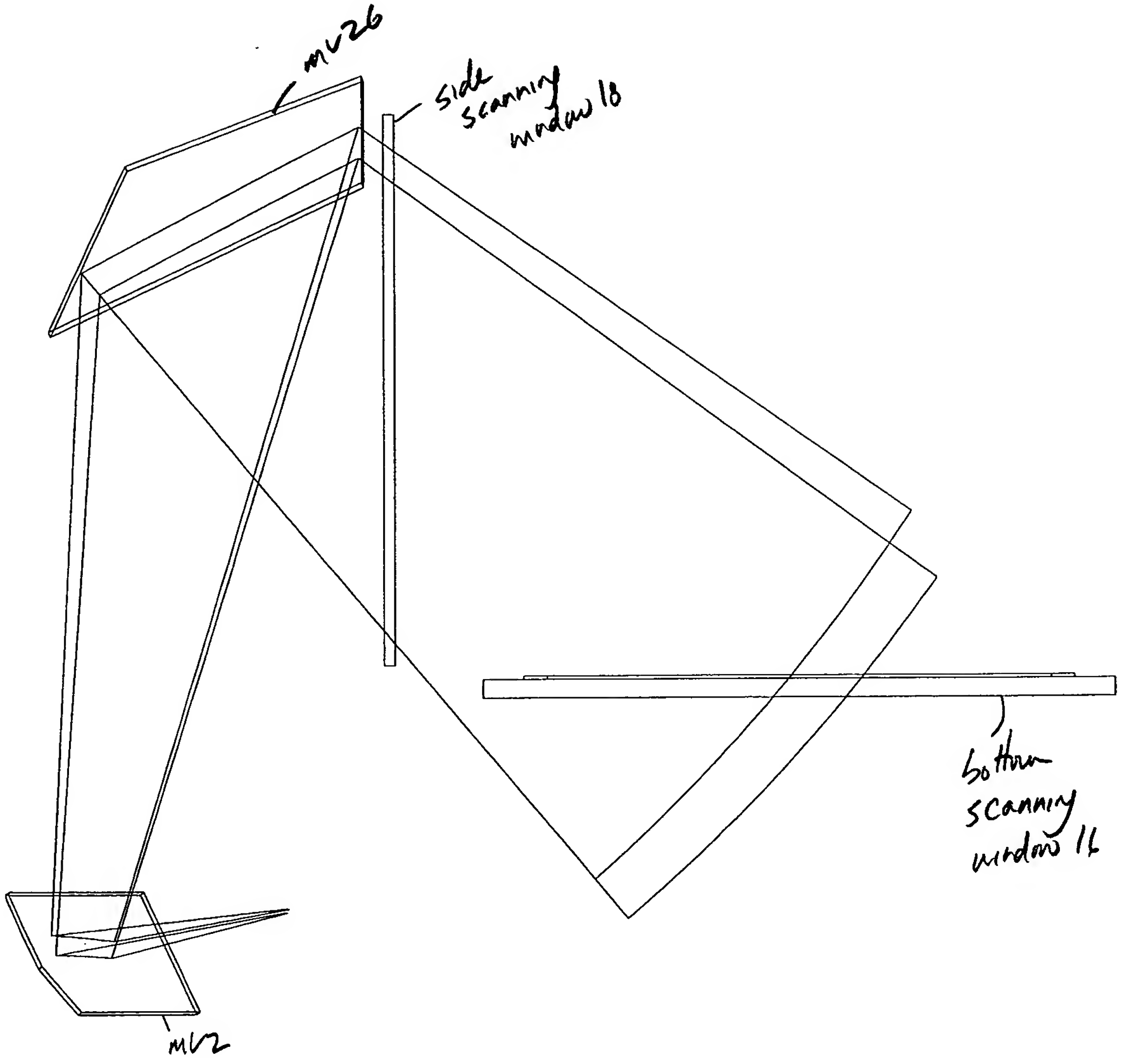
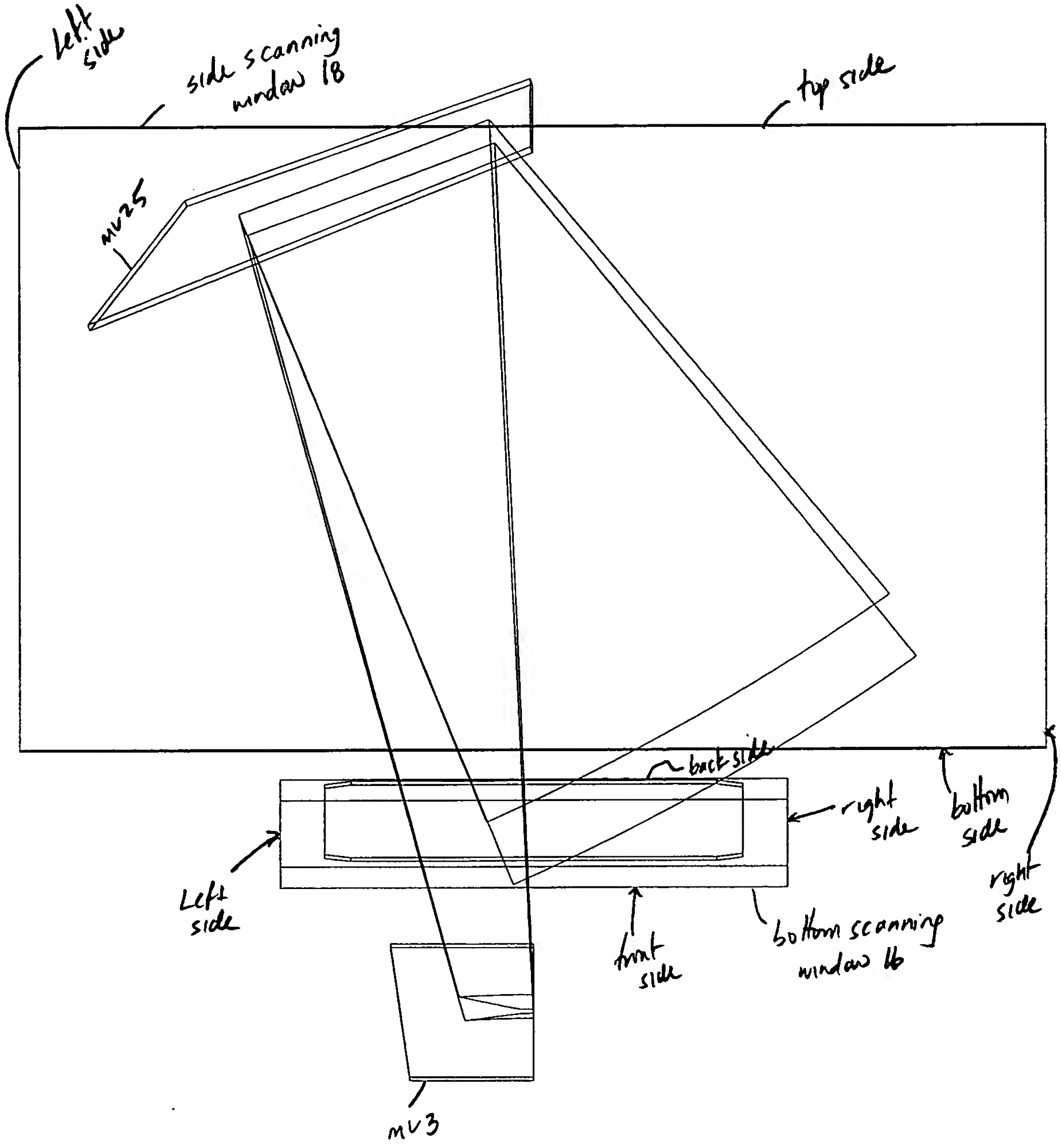
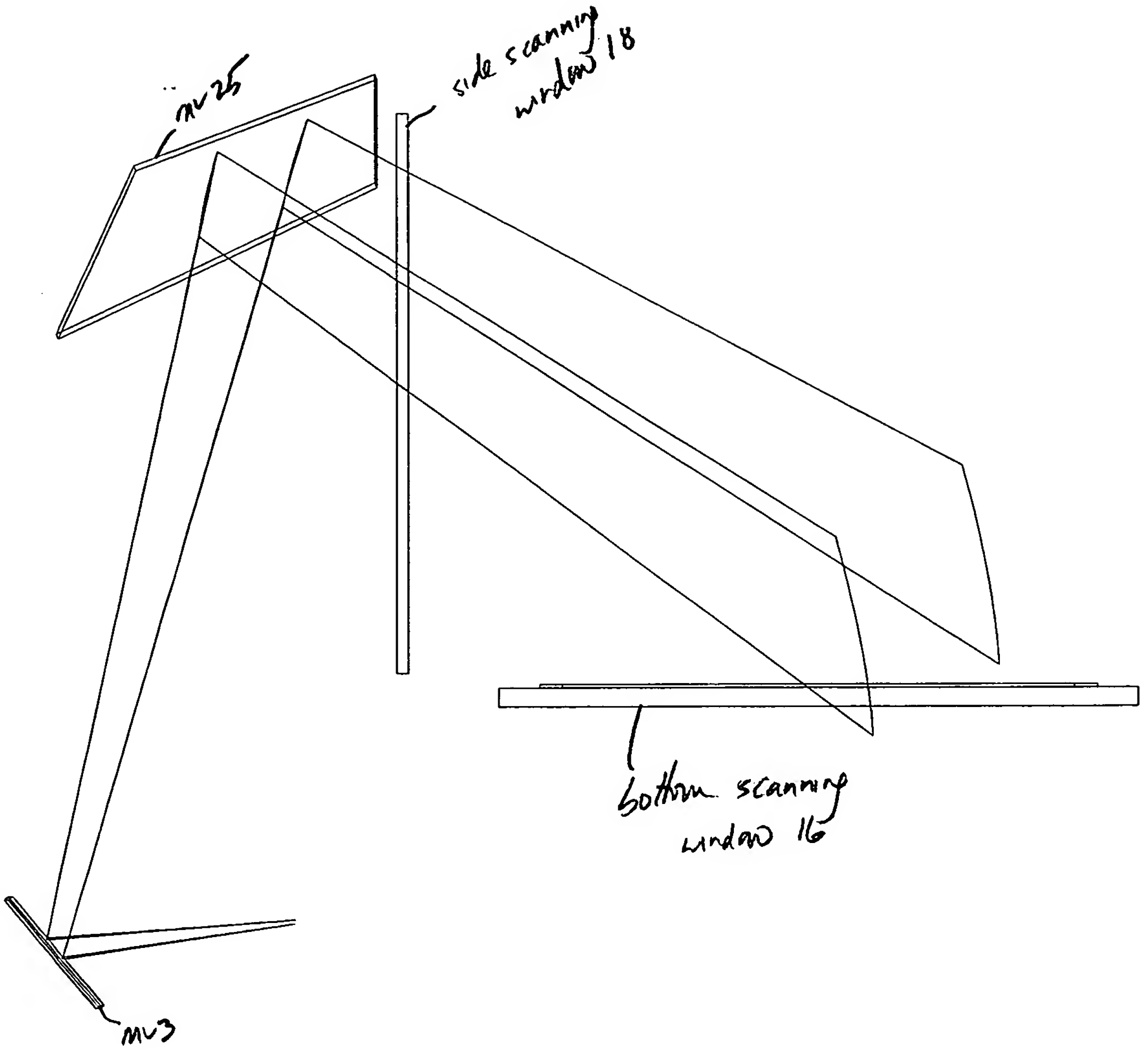

MV26
side scanning window 18
bottom scanning window 16
MV2

FIG. 5E1


left side
side scanning window 18
top side
MV25
back side
right side
bottom side
right side
Left side
front side
bottom scanning window 16
MV3

10045605.011102

FIG 5E2


MV25
side scanning window 18
bottom scanning window 16
MV3

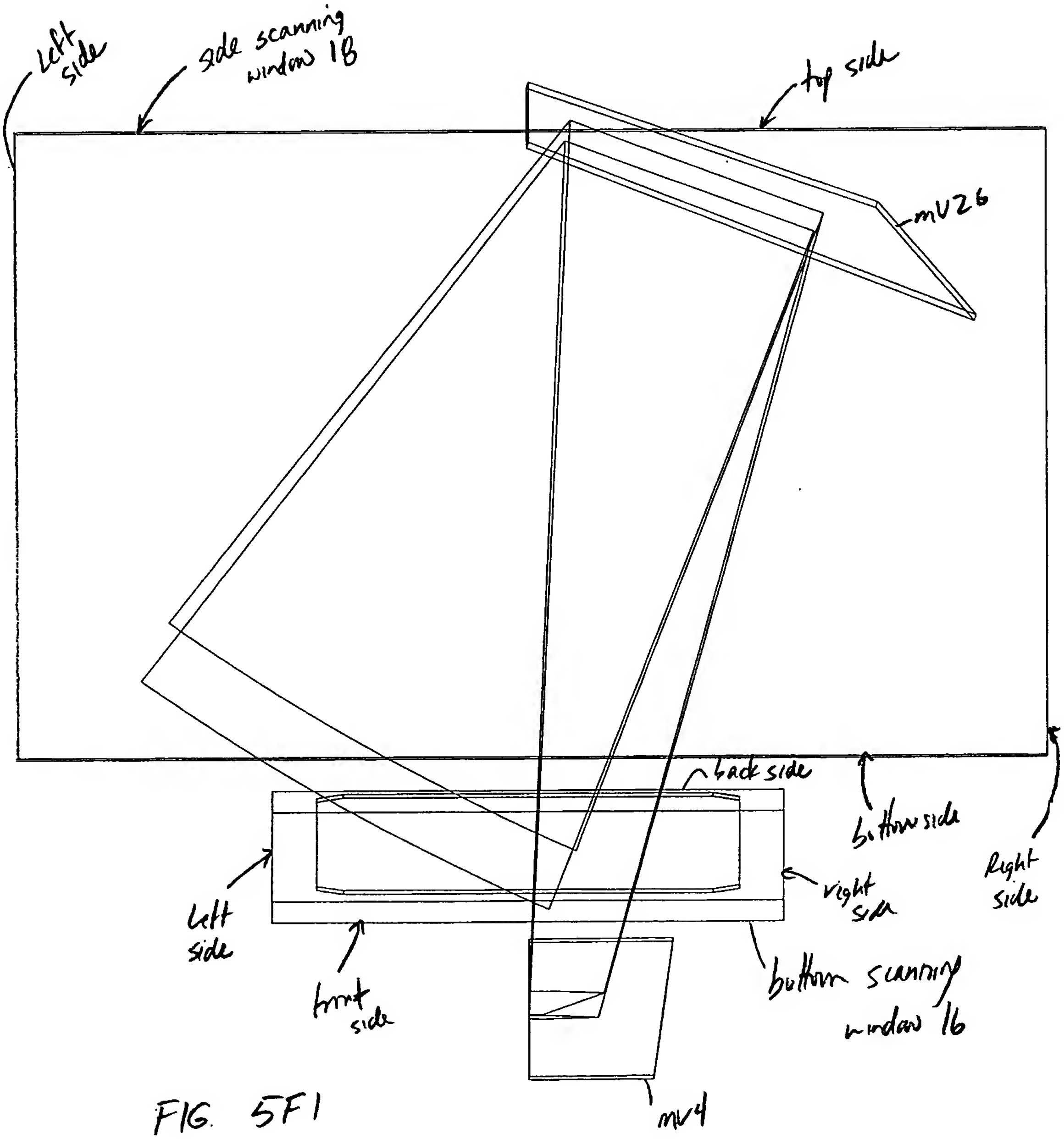
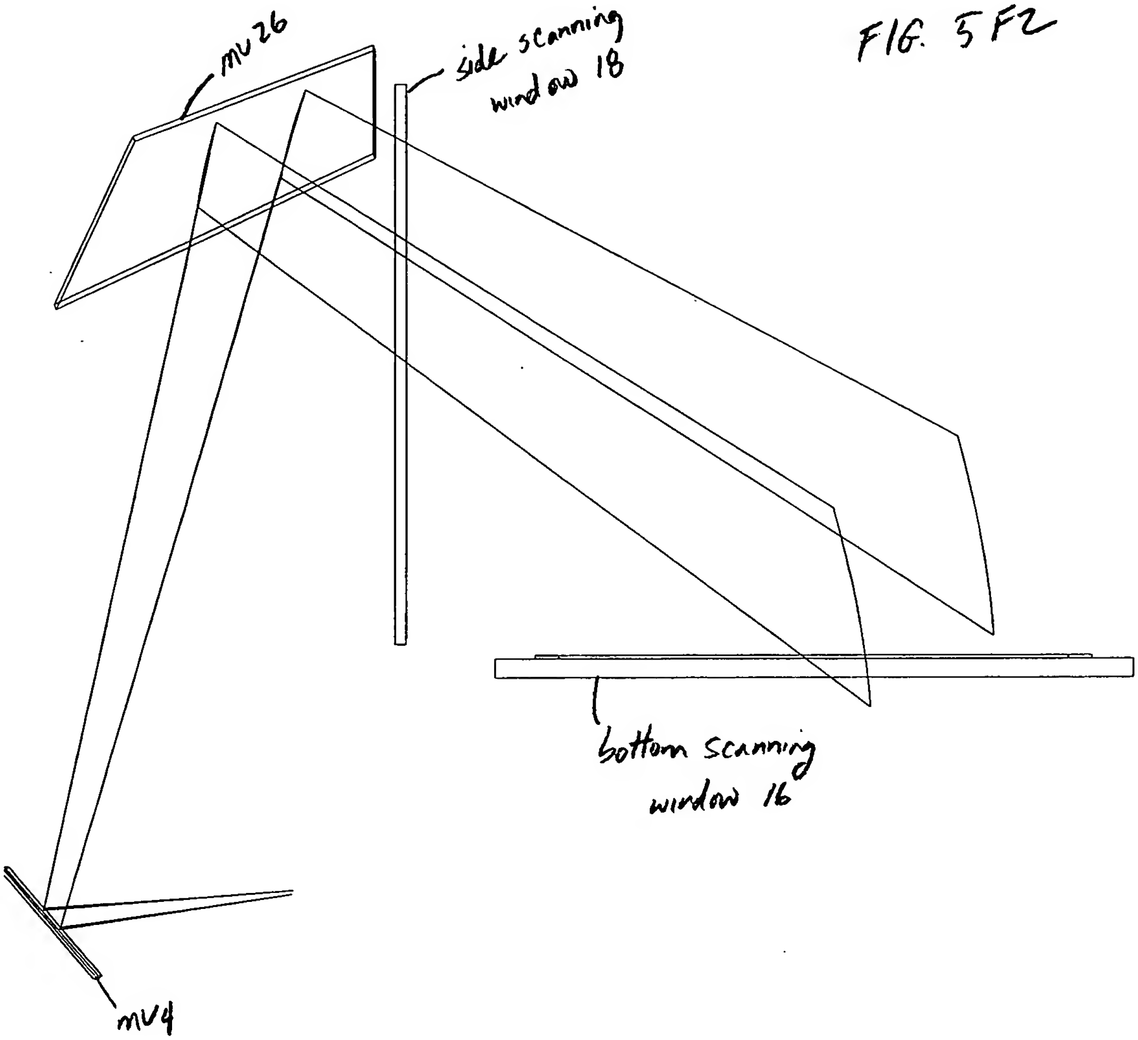

left side
side scanning window 18
top side
mV26
back side
bottom side
right side
left side
right side
front side
bottom scanning window 16
mv4

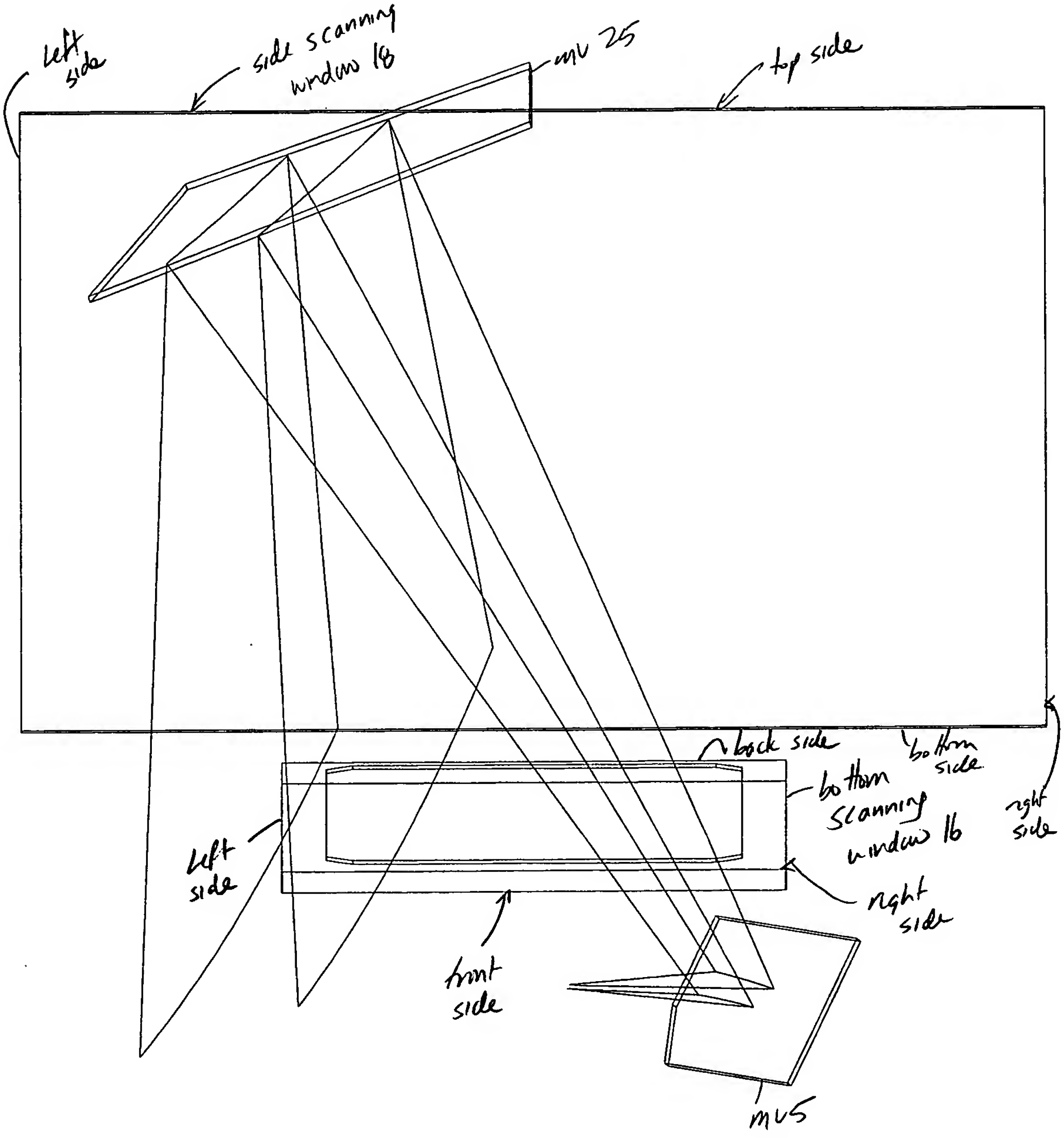
FIG. 5F1

FIG. 5F2


mv26
side scanning window 18
bottom scanning window 16
mv4

10045605 .011102

FIG. 5G1


left side
side scanning window 18
mv 25
top side
back side
bottom side
bottom scanning window 16
right side
left side
right side
front side
mv5

10045605 .011102

55/88

FIG. 562

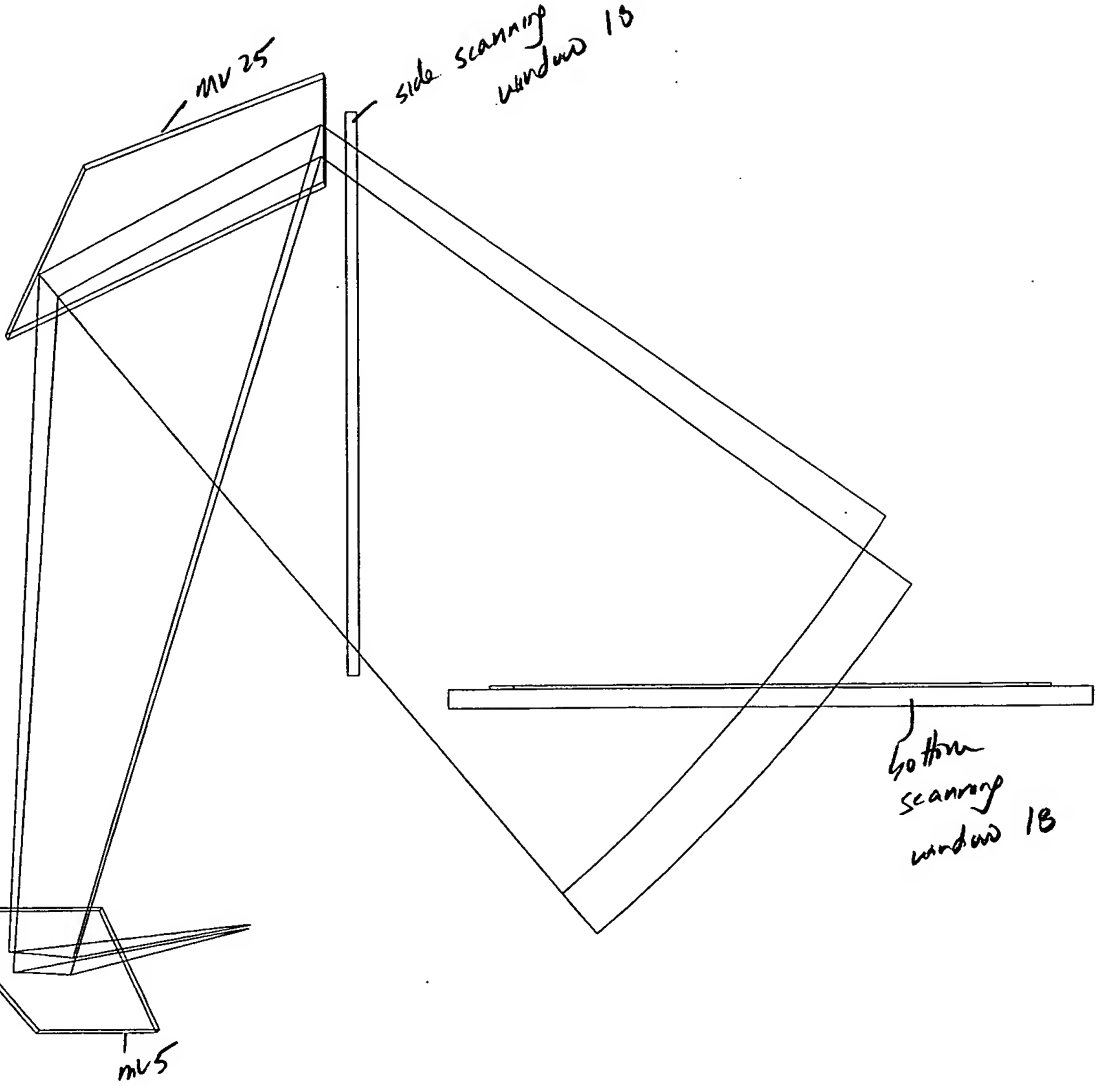

mv25
side scanning window 18
bottom scanning window 18
mv5

FIG. 5H1

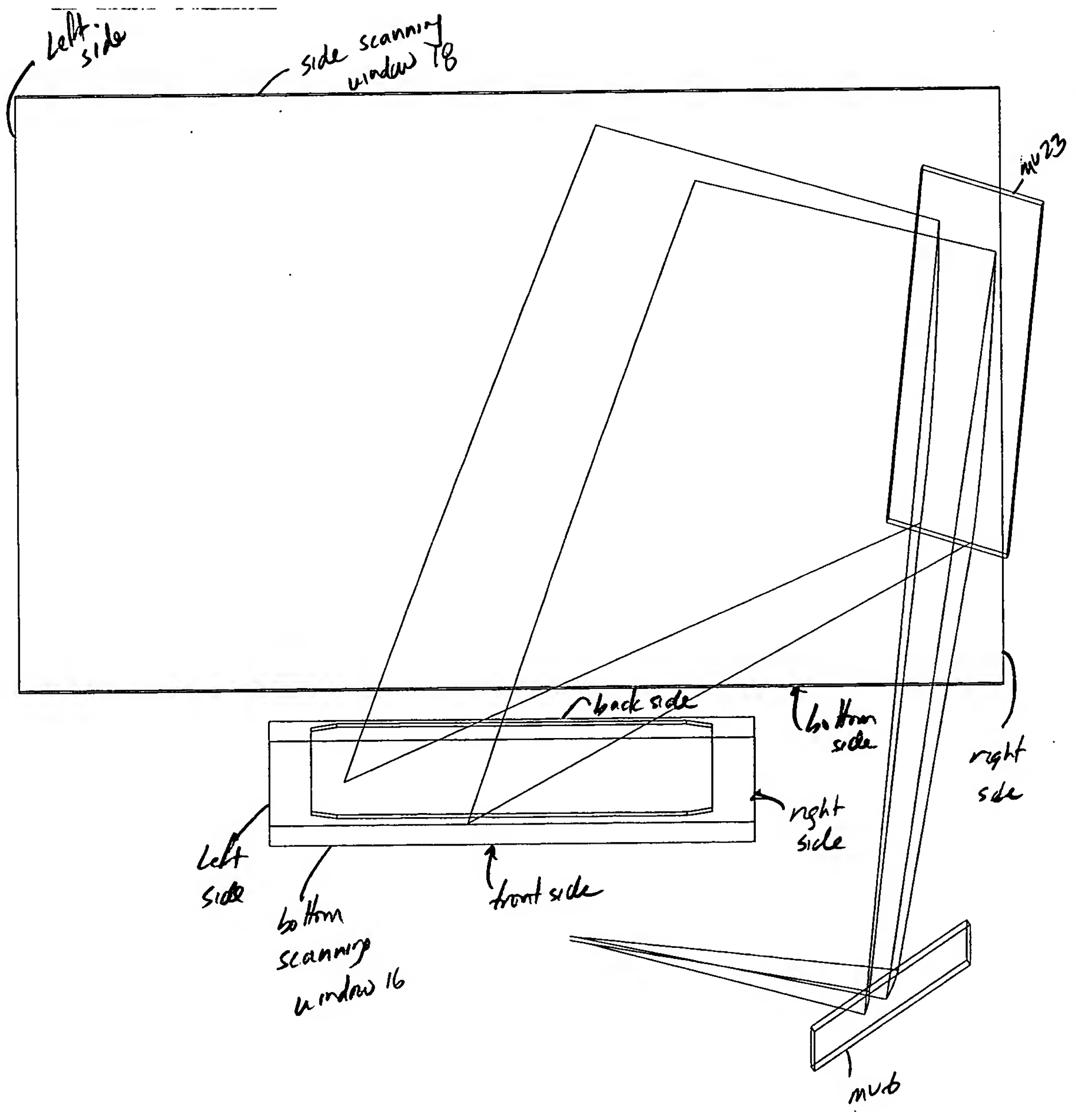
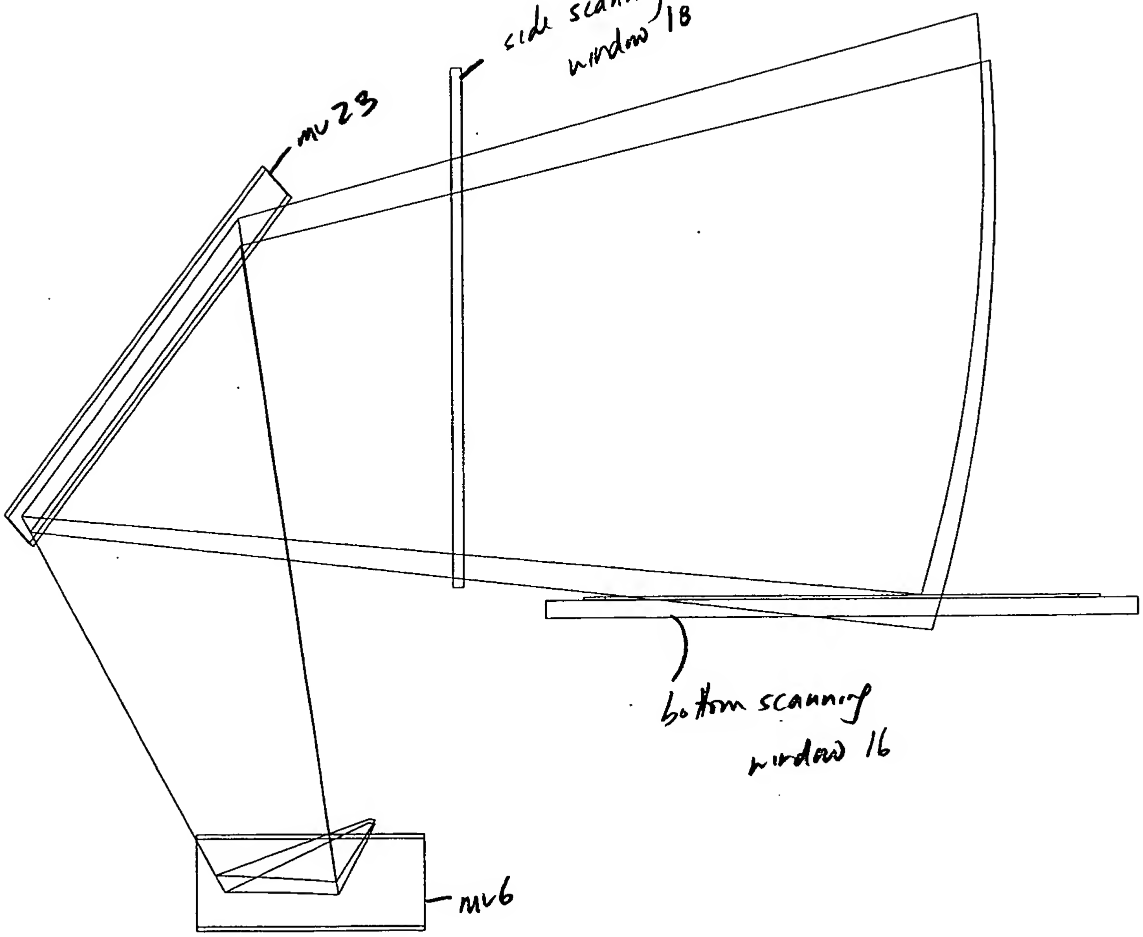
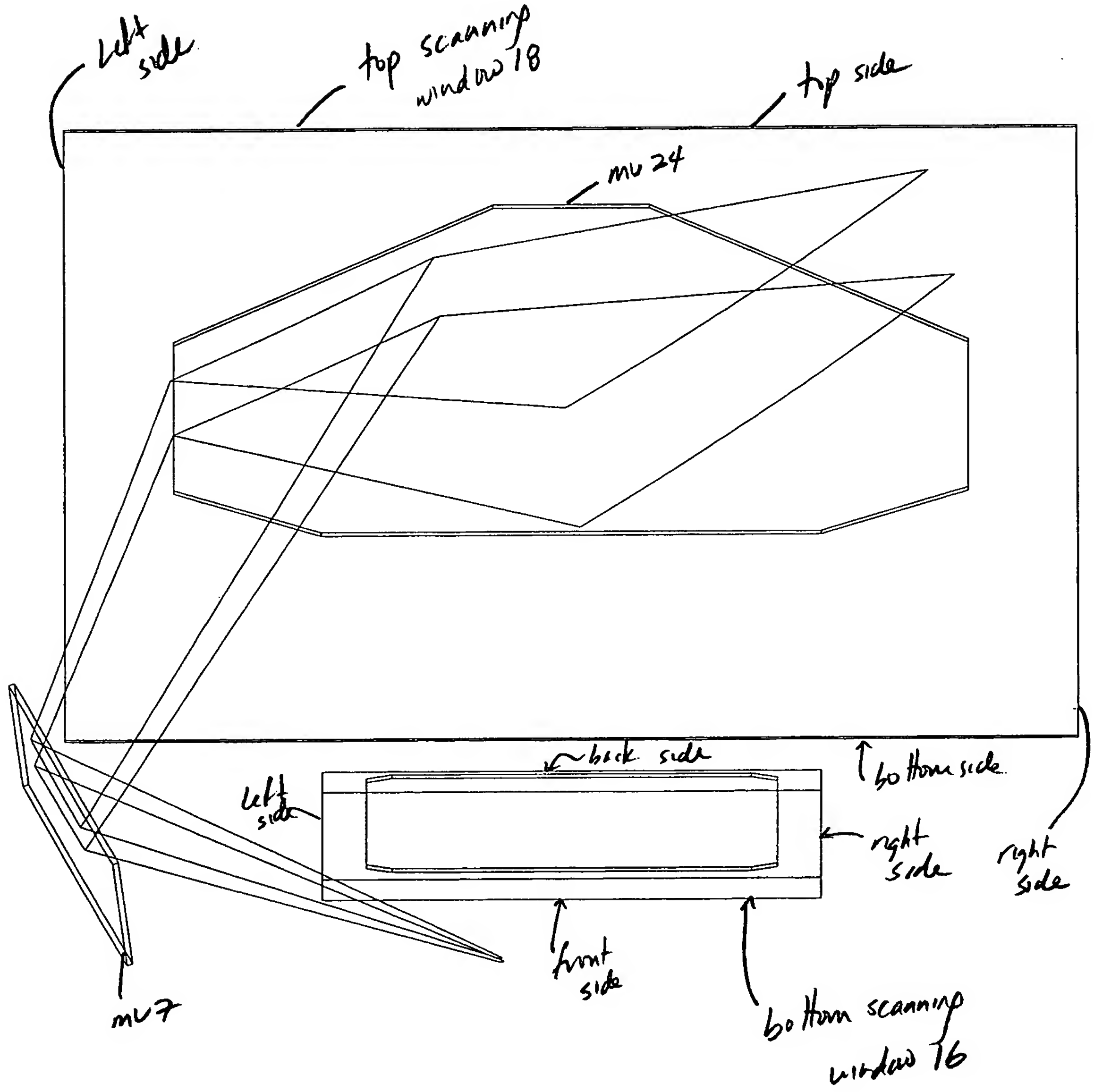

left side
side scanning window 18
mv23
back side
bottom side
right side
right side
left side
bottom scanning window 16
front side
mvb

FIG 5H2


side scanning window 18
mv23
bottom scanning window 16
mv6

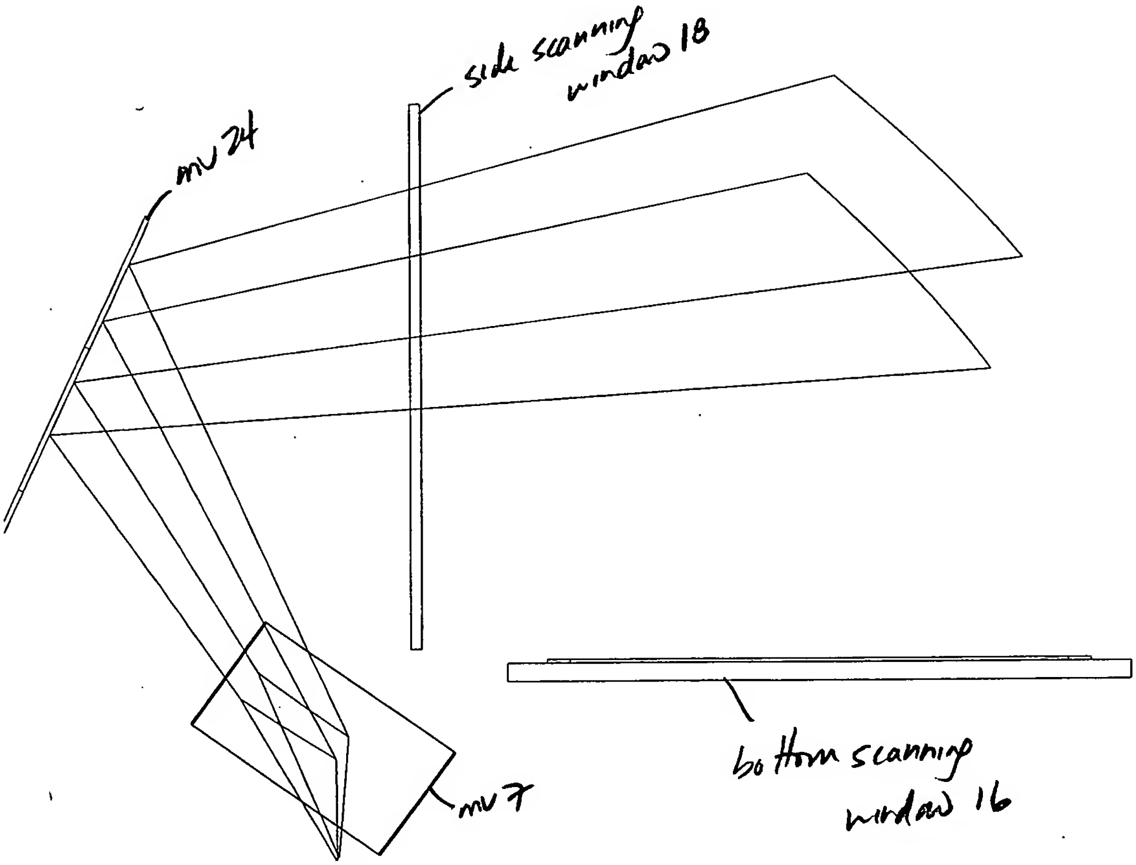
10045605.011102

FIG. 5I1


left side
top scanning window 18
top side
mv 24
back side
bottom side
left side
right side
right side
mv 7
front side
bottom scanning window 16

59/88

FIG. 5I2


side scanning window 18
mv 24
mv 7
bottom scanning window 16

10045605.011102

FIG. 5J1

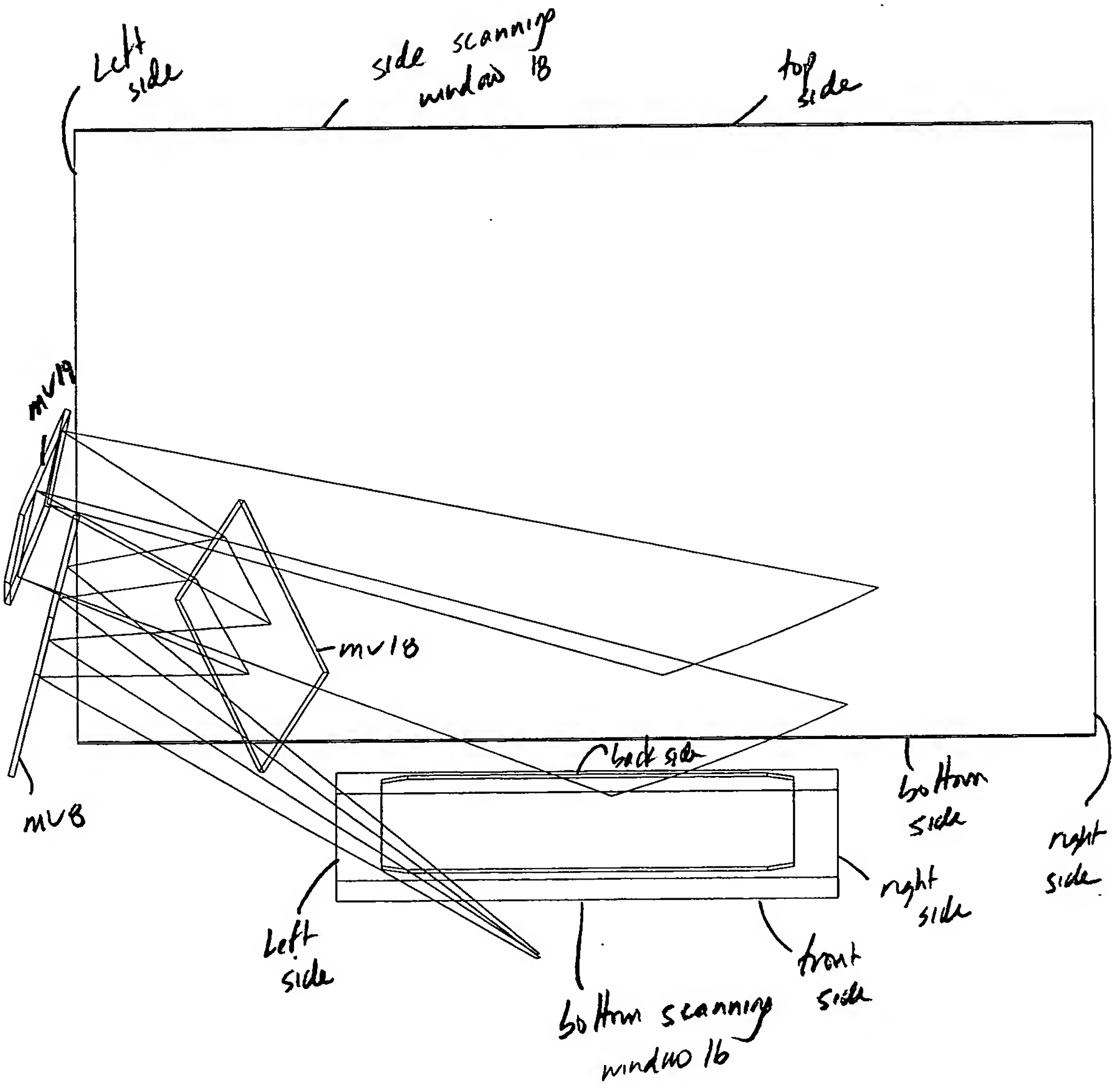

Left side
side scanning window 18
top side
mv19
mv18
mv8
back side
bottom side
right side
right side
left side
front side
bottom scanning window 16

FIG 5J2

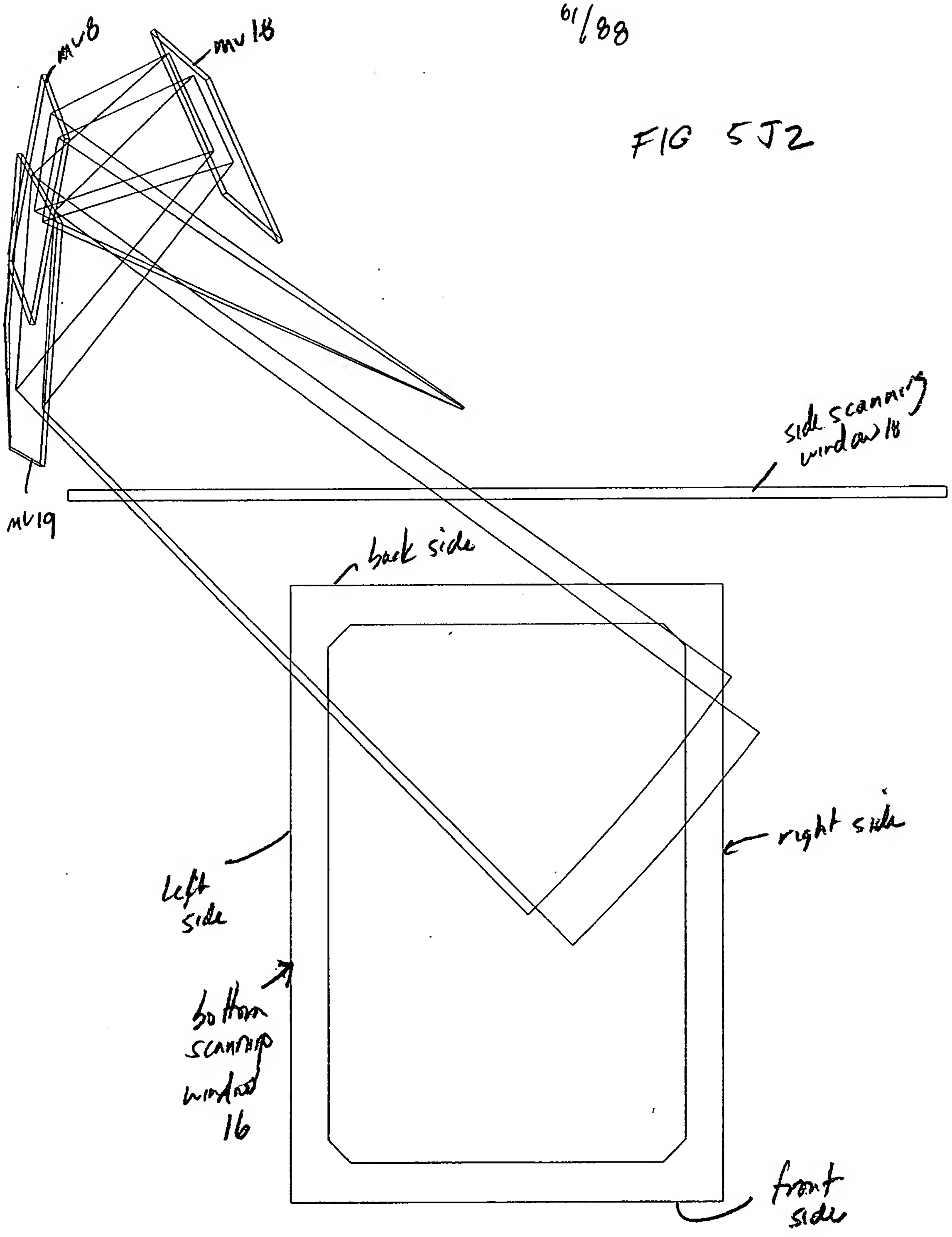

mv8
mv18
side scanning window 18
mv19
back side
left side
right side
bottom scanning window 16
front side

FIG. 5K1

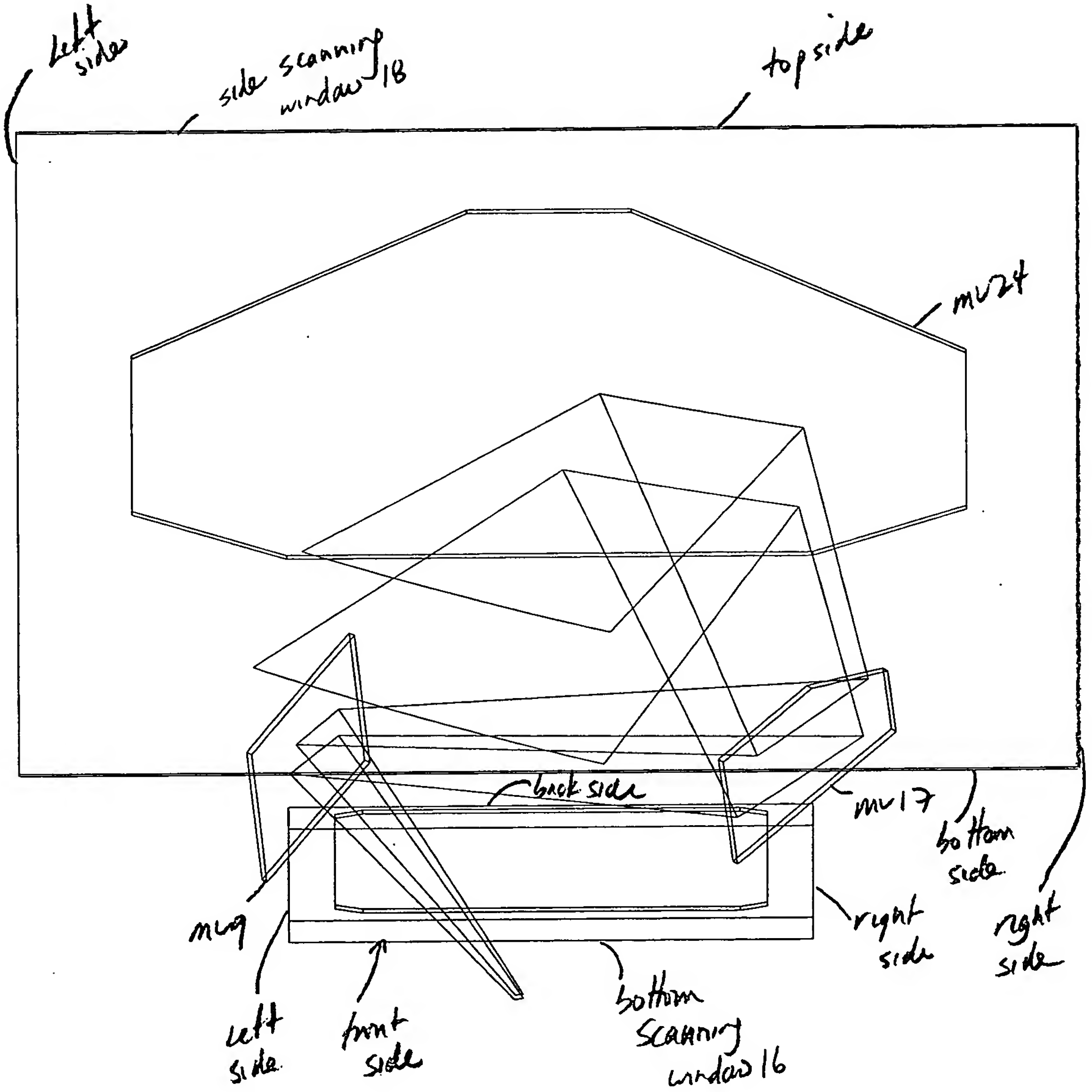
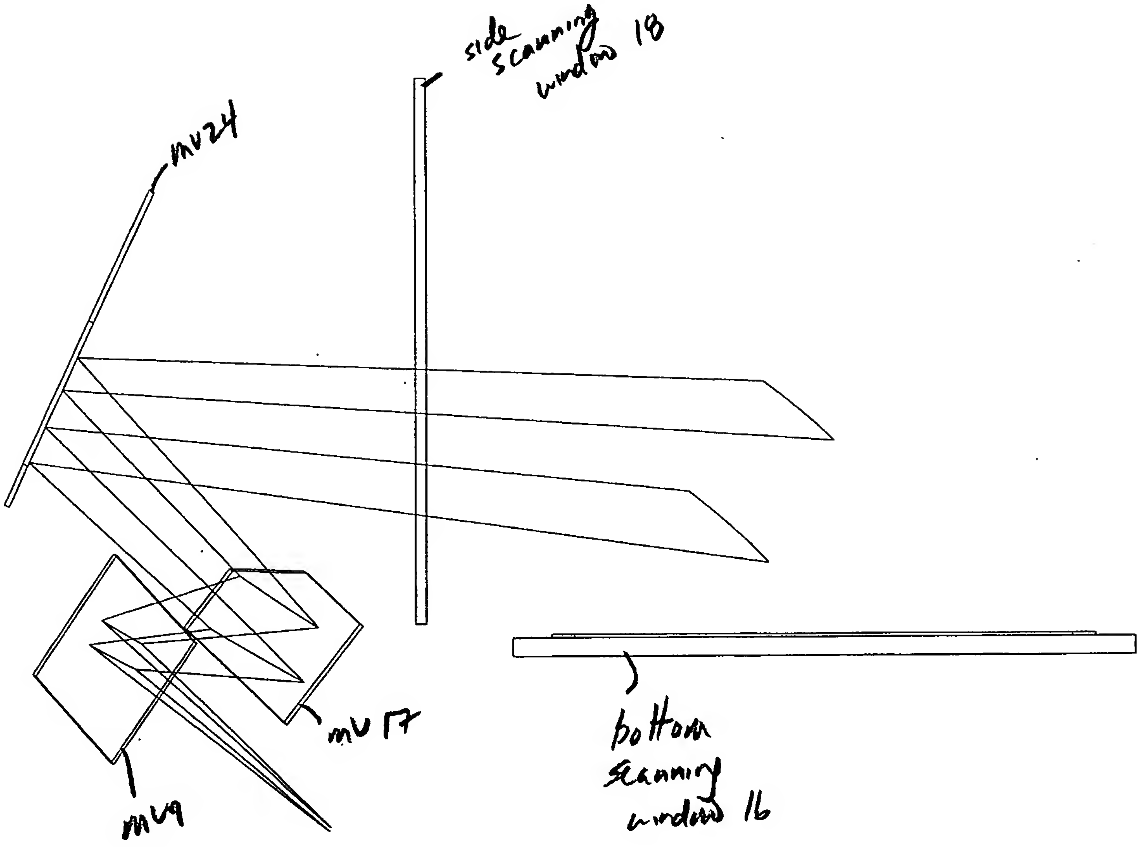

left side
side scanning window 18
topside
mv24
back side
mv17
bottom side
right side
mv9
left side
front side
bottom scanning window 16
right side

FIG. 5K2


side scanning window 18
mv24
mv17
mv9
bottom scanning window 16

10045605 .011102

FIG. 5L1

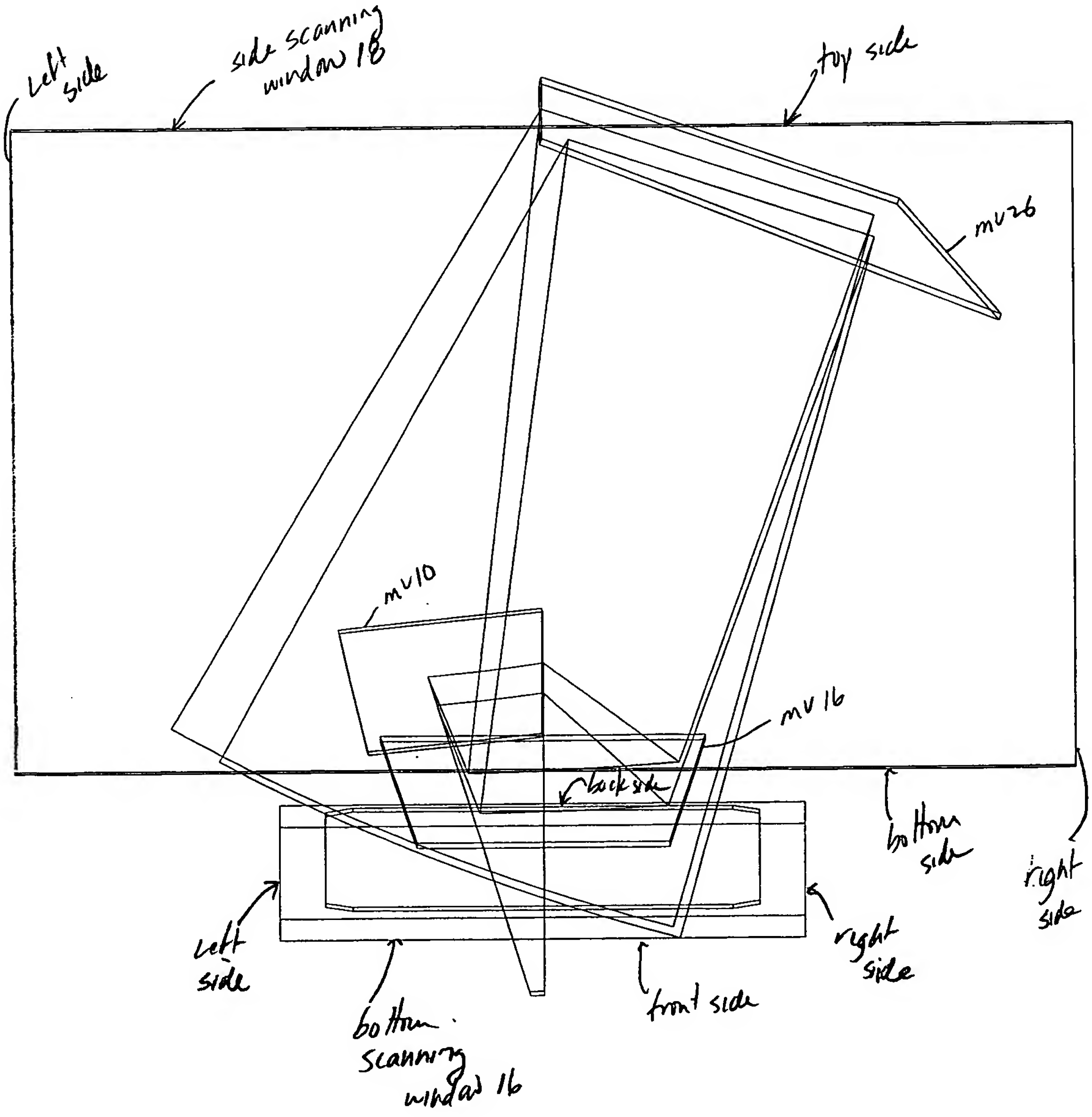
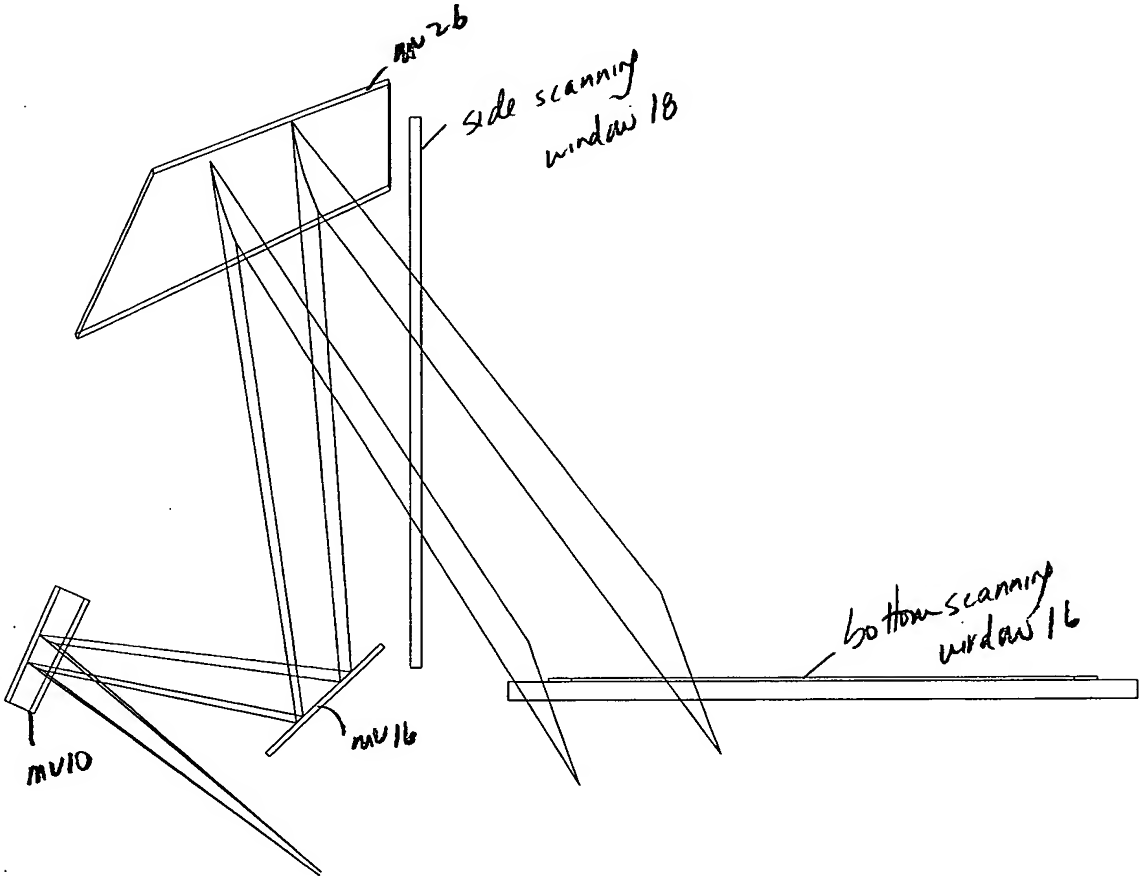
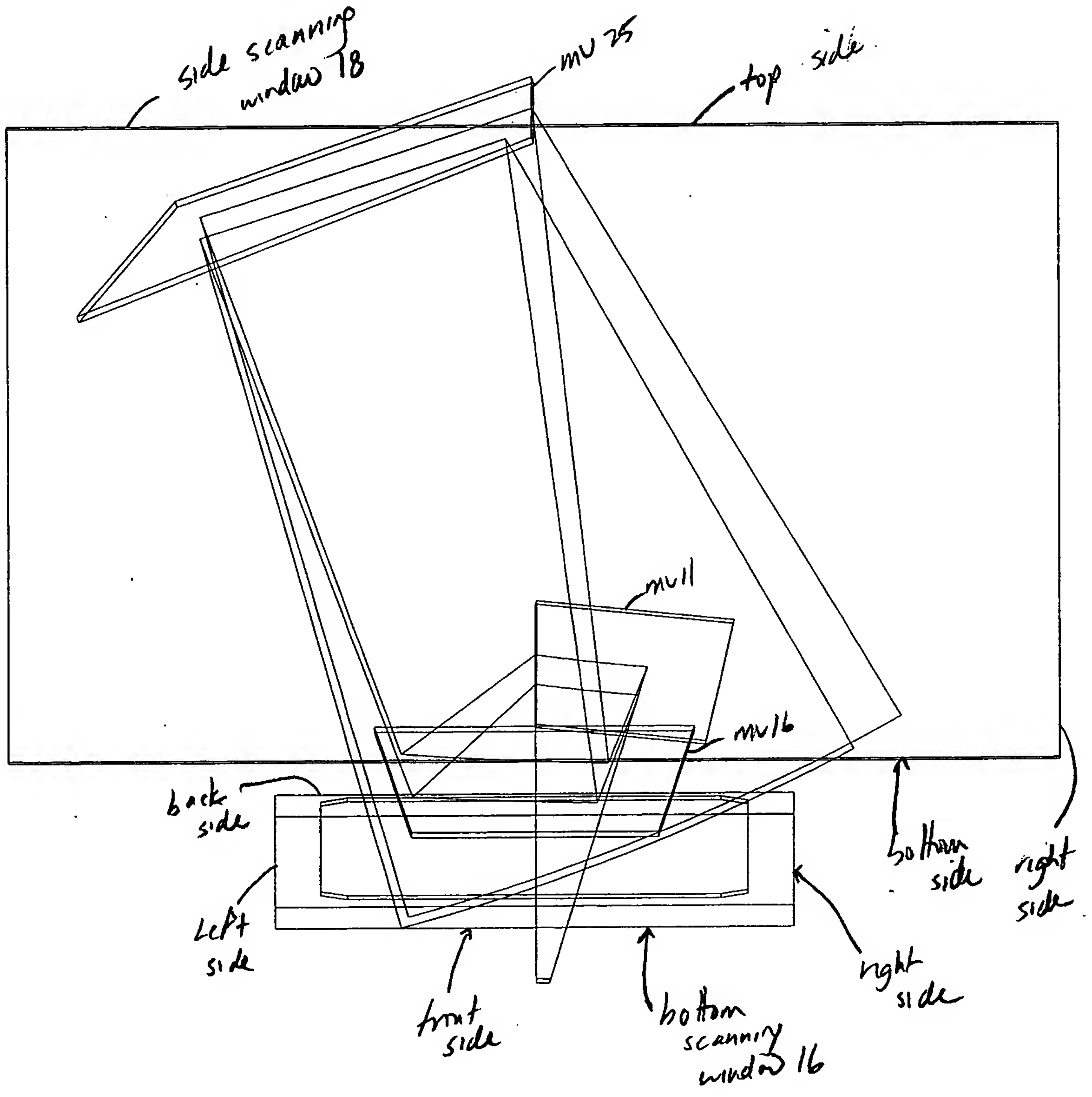

left side
side scanning window 18
top side
mv26
mv10
mv16
back side
bottom side
right side
left side
bottom scanning window 16
front side
right side

FIG. 5L2


mv26
side scanning window 18
bottom scanning window 16
mv10
mv16

66/88

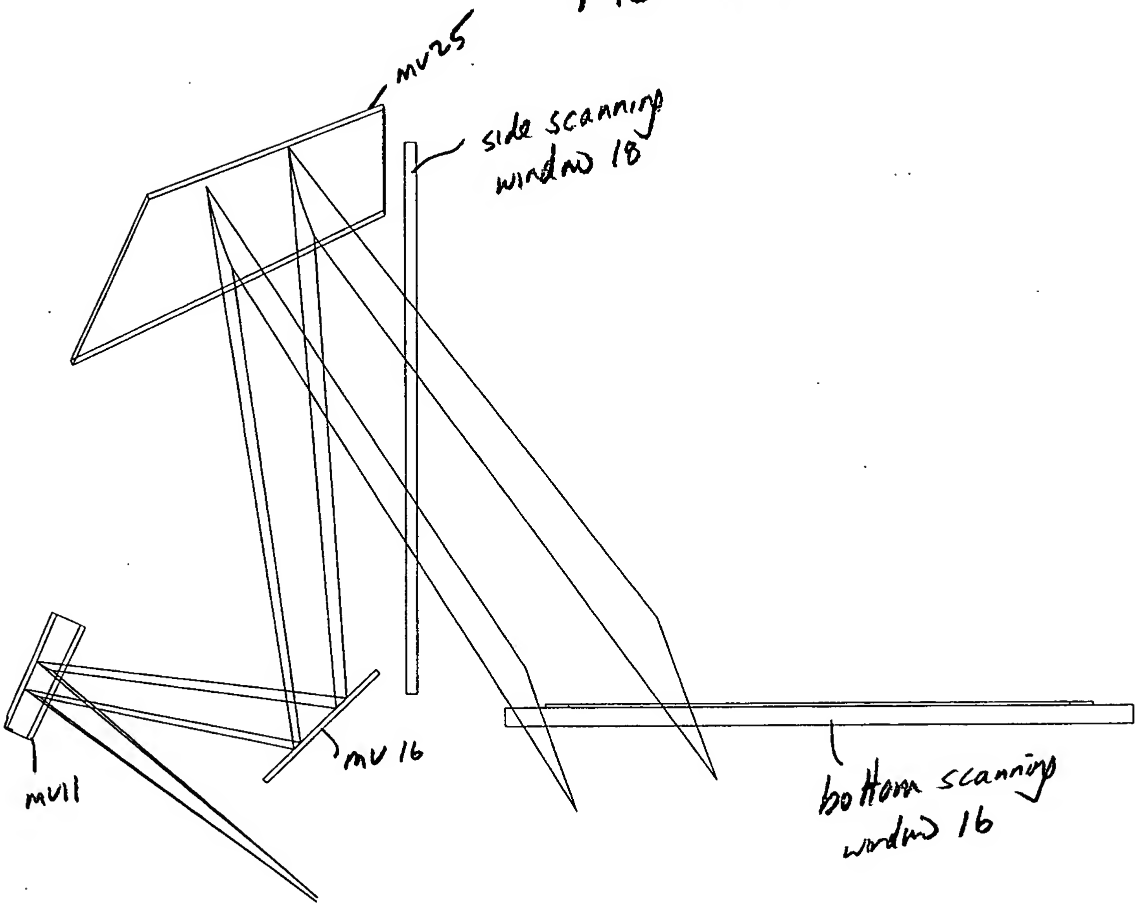
FIG. 5M1



side scanning window 18
mv 25
top side
mv 11
mv 16
back side
left side
front side
bottom scanning window 16
right side
bottom side
right side

10045605.011102

FIG. 5M2


mv25
side scanning window 18
mv11
mv16
bottom scanning window 16

10045605 .011102

68/88

FIG. 5N1

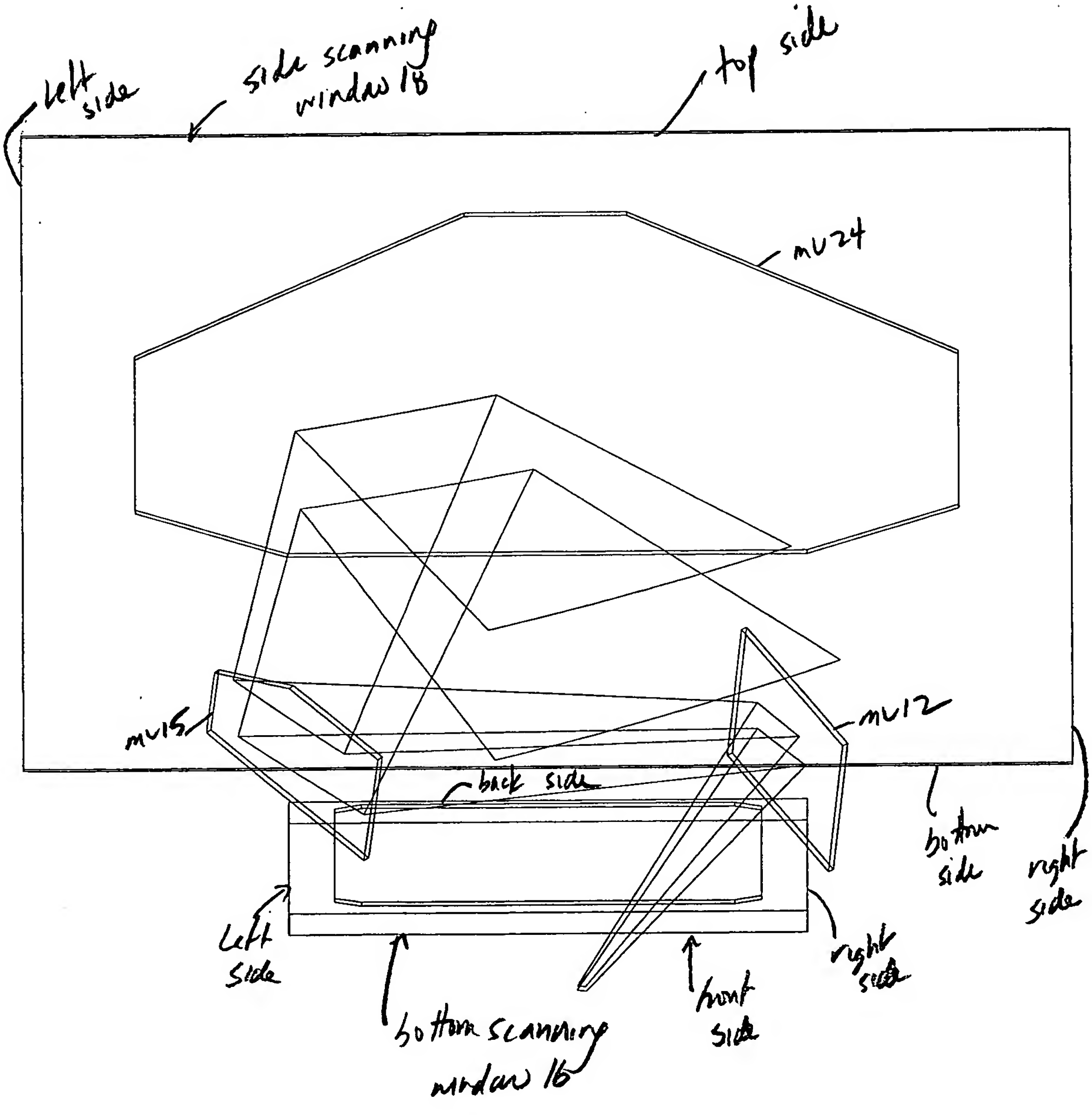

left side
side scanning window 18
top side
mv24
mv15
mv12
back side
bottom side
right side
left side
right side
front side
bottom scanning window 16

FIG. 5N2

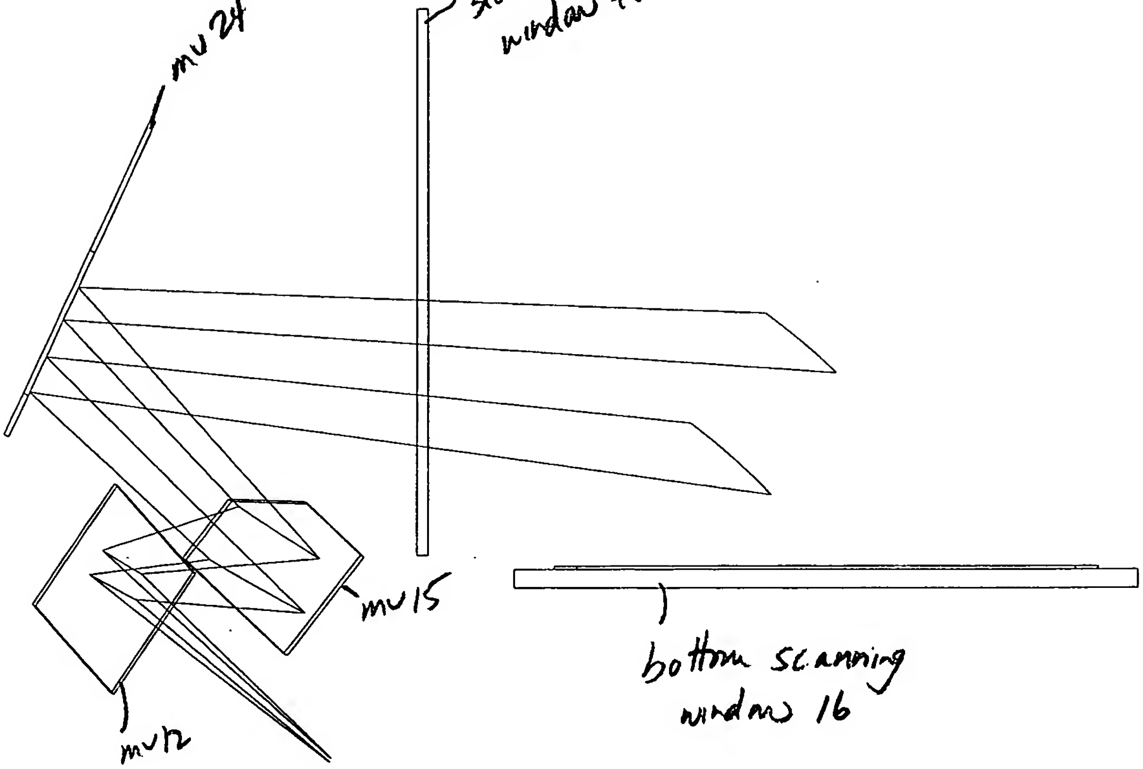
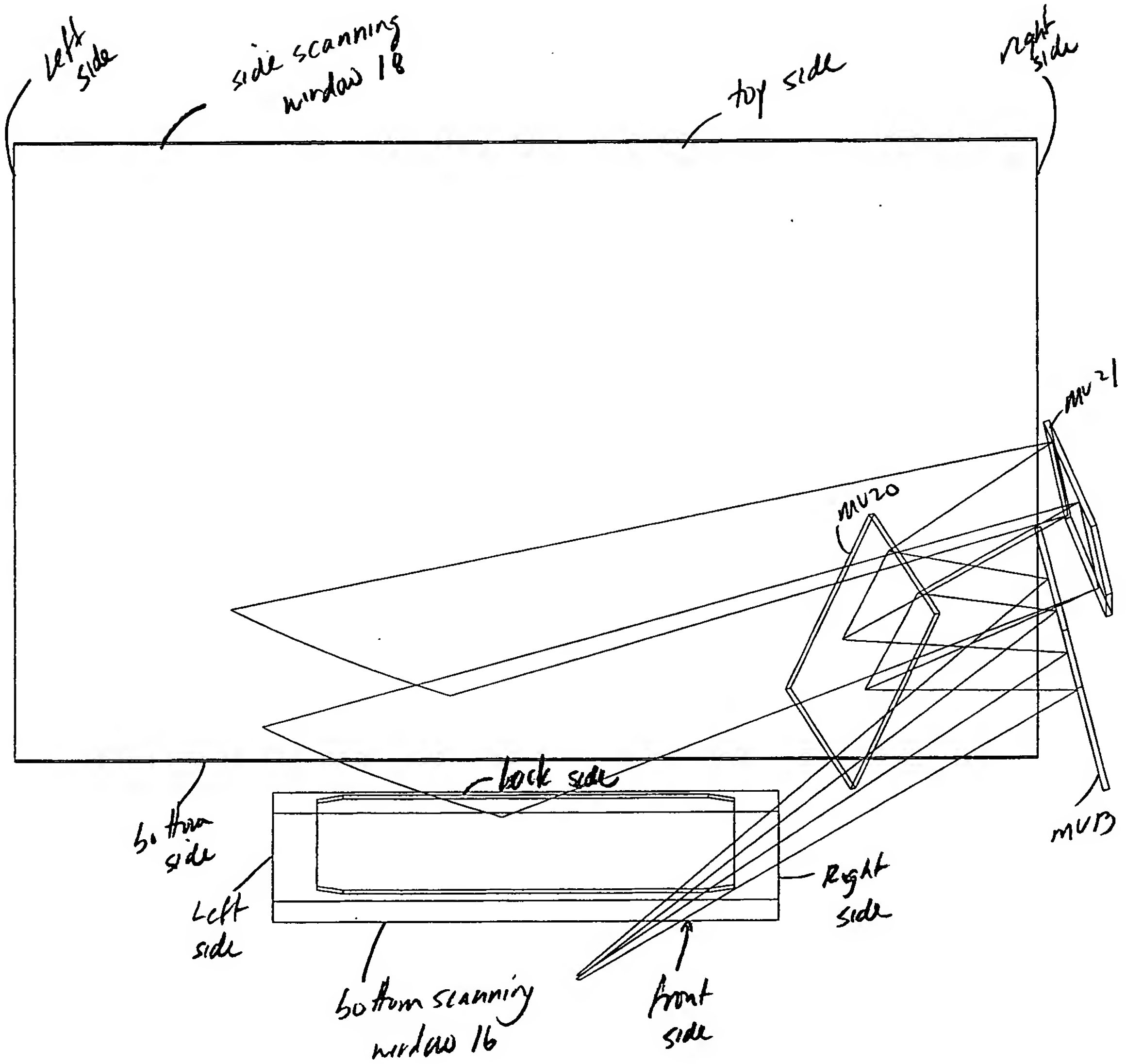

side scanning window 18
mv24
mv15
mv12
bottom scanning window 16

FIG. 501


left side
side scanning window 18
top side
right side
MV21
MV20
MV13
bottom side
back side
Left side
Right side
bottom scanning window 16
front side

10045308.011102

71/88

FIG. 502

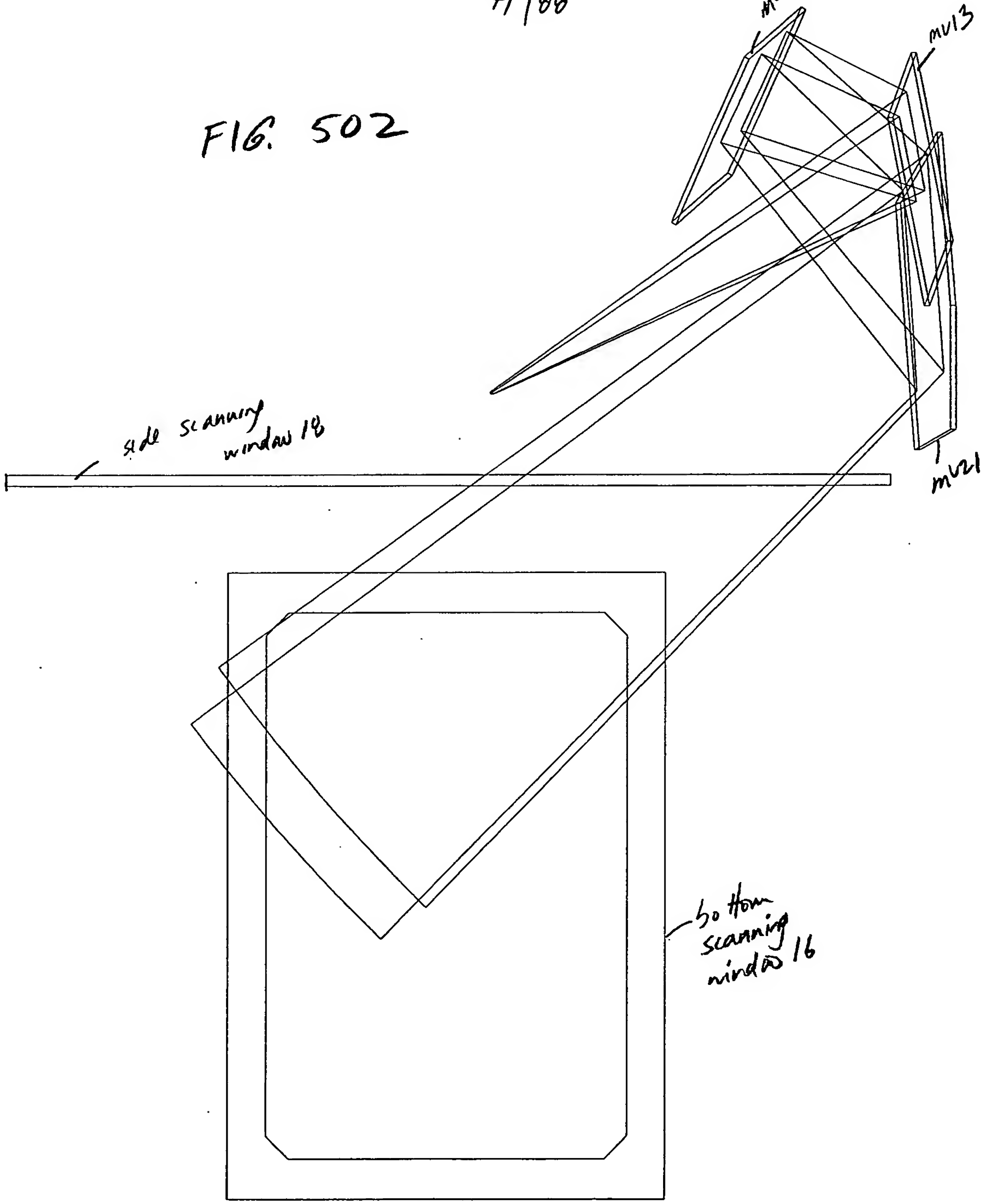
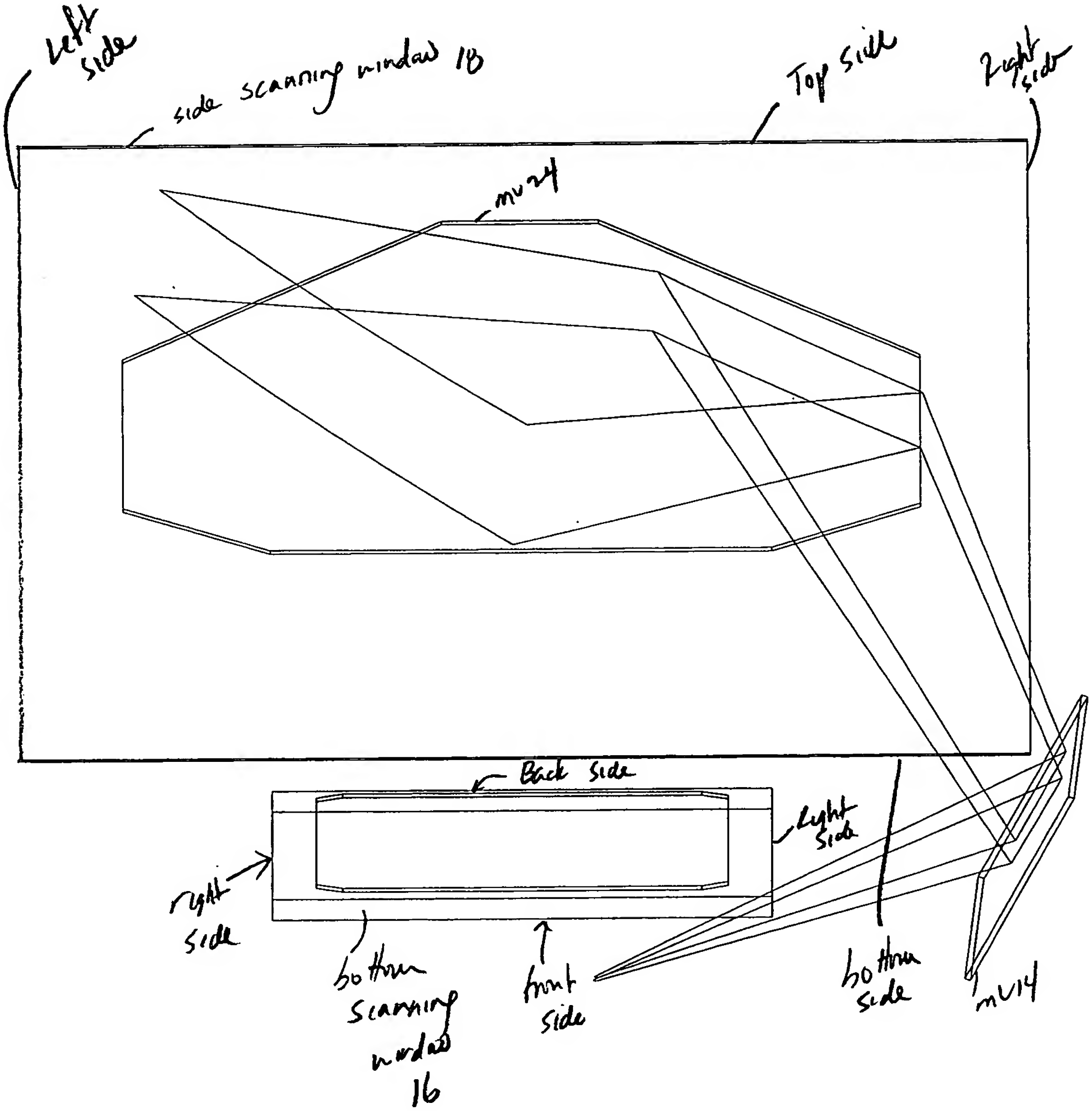
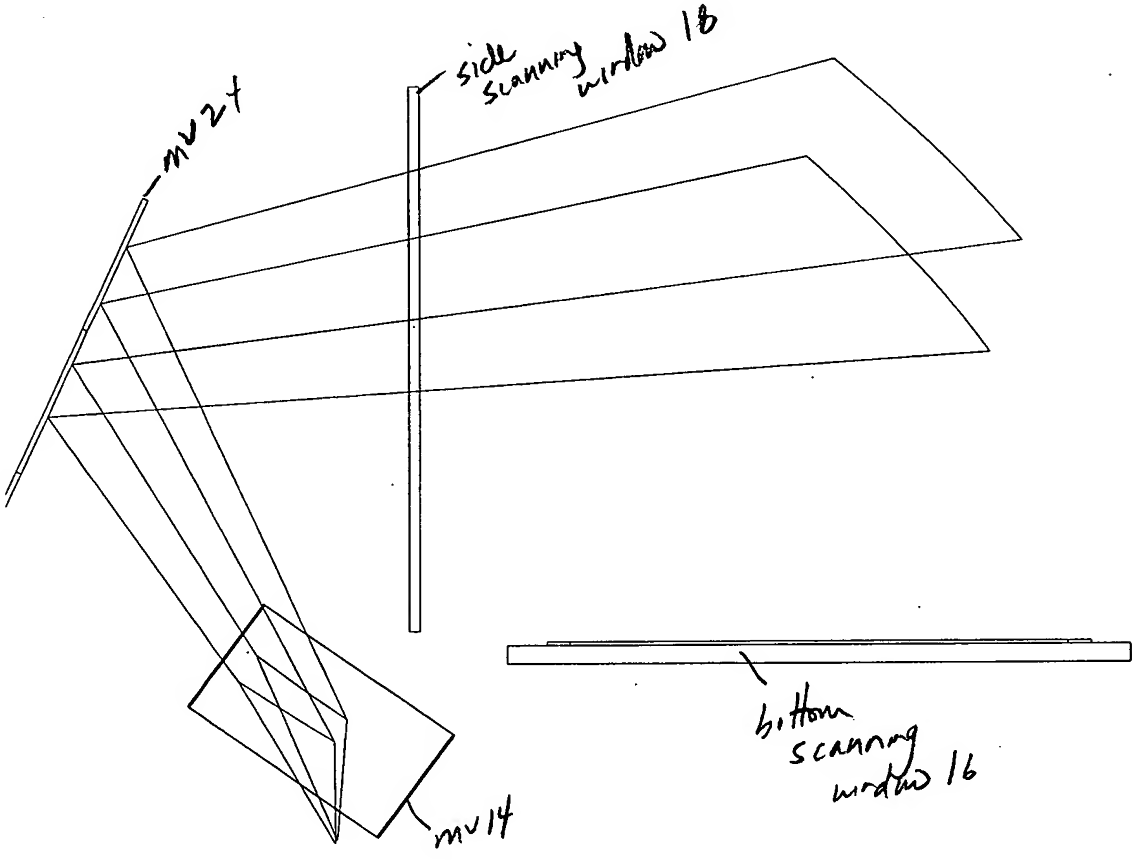

mv20
mv13
mv21
side scanning window 18
bottom scanning window 16

FIG. 5P1



left side
side scanning window 18
Top side
Right side
mv24
Back side
light side
right side
bottom scanning window 16
front side
bottom side
mv14

FIG. 5P2


side scanning window 18
mv24
bottom scanning window 16
mv14

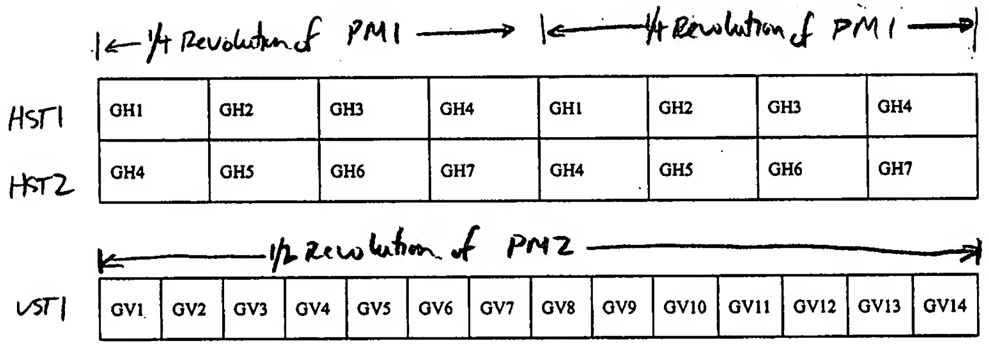

|← 1/4 Revolution of PM1 →
|← 1/4 Revolution of PM1 →|
HST1
GH1
GH2
GH3
GH4
GH1
GH2
GH3
GH4
HST2
GH4
GH5
GH6
GH7
GH4
GH5
GH6
GH7
|← 1/2 Revolution of PM2 →|
VST1
GV1
GV2
GV3
GV4
GV5
GV6
GV7
GV8
GV9
GV10
GV11
GV12
GV13
GV14

FIG. 6

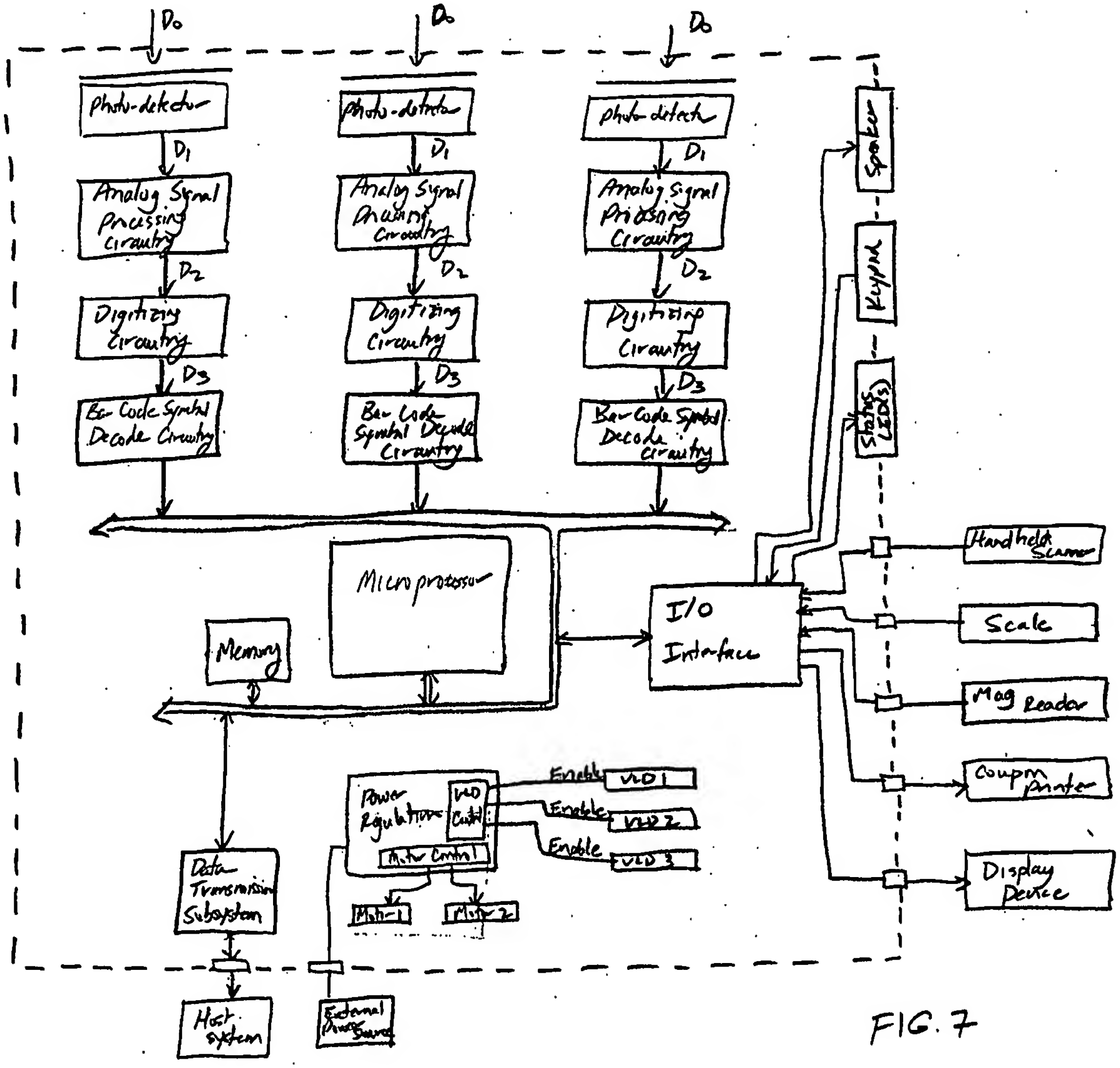

D0
D0
D0
Photo-detector
Photo-detector
Photo-detector
D1
D1
D1
Analog Signal Processing Circuitry
Analog Signal Processing Circuitry
Analog Signal Processing Circuitry
D2
D2
D2
Digitizing Circuitry
Digitizing Circuitry
Digitizing Circuitry
D3
D3
D3
Bar Code Symbol Decode Circuitry
Bar Code Symbol Decode Circuitry
Bar Code Symbol Decode Circuitry
Speaker
Keypad
Status LED(s)
Microprocessor
Memory
I/O Interface
Handheld Scanner
Scale
Mag Reader
Coupon Printer
Display Device
Power Regulations
VLD Cntrl
Motor Control
Enable
Enable
Enable
VLD 1
VLD 2
VLD 3
Motor 1
Motor 2
Data Transmission Subsystem
Host system
External Power Source

FIG. 7

10045605 .011102

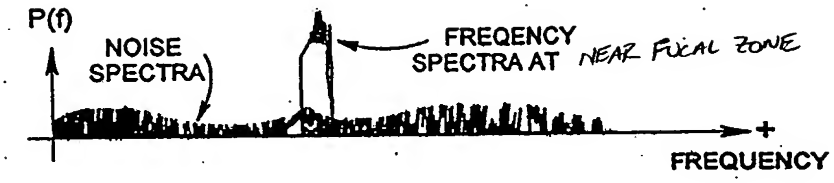


FIG. 8A

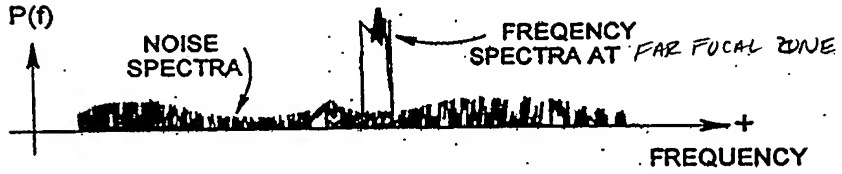


FIG. 8B

10045605 .011702

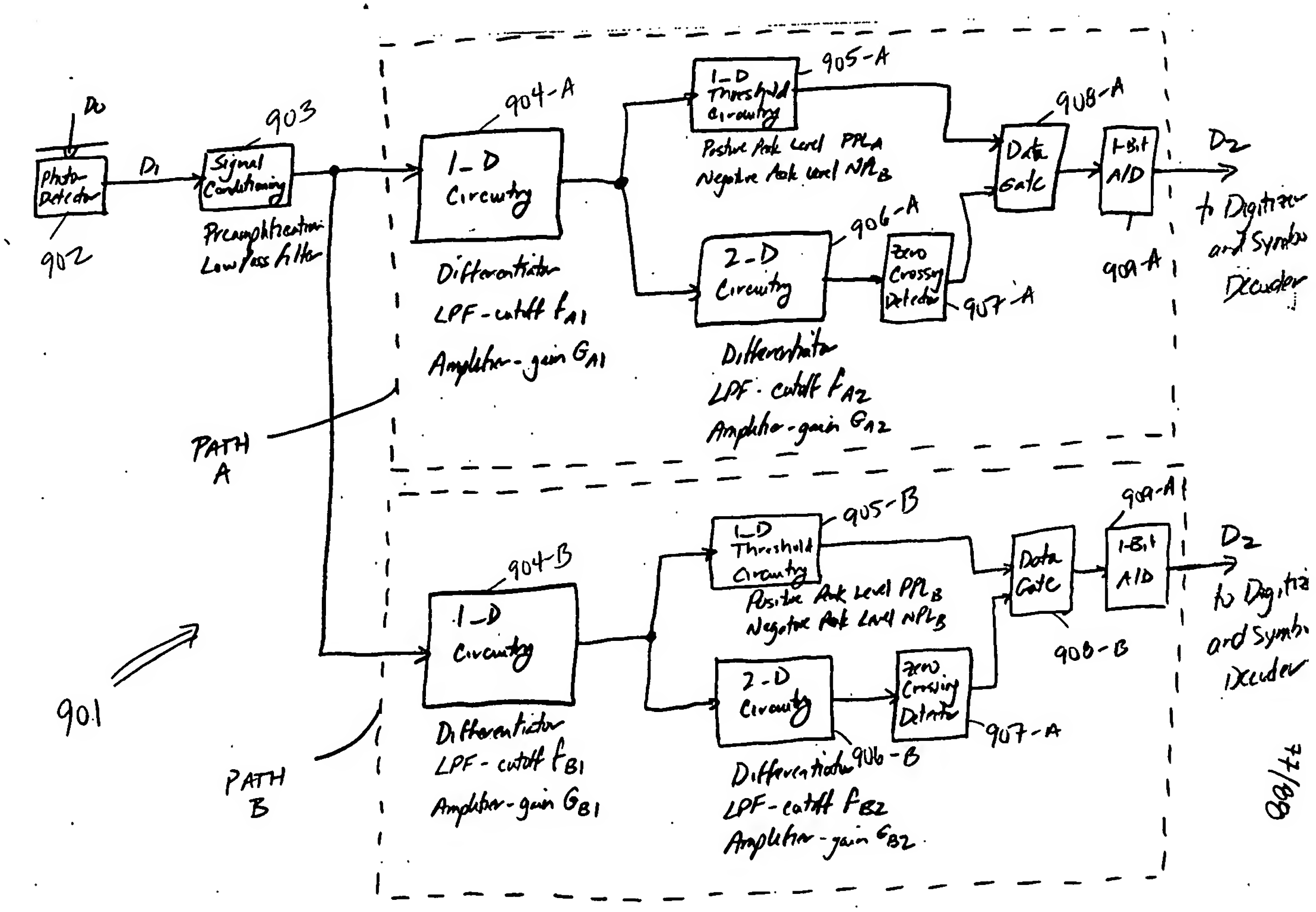

D0
Photo-Detector
902
D1
903
Signal Conditioning
Preamplification
Low Pass filter
904-A
1-D Circuitry
Differentiator
LPF-cutoff f_{A1}
Amplifier-gain G_{A1}
905-A
1-D Threshold Circuitry
Positive Peak Level PPL_A
Negative Peak Level NPL_B
906-A
2-D Circuitry
Differentiator
LPF-cutoff f_{A2}
Amplifier-gain G_{A2}
Zero Crossing Detector
907-A
908-A
Data Gate
1-Bit A/D
909-A
D_2
to Digitizer and Symbol Decoder
PATH A
904-B
1-D Circuitry
Differentiator
LPF-cutoff f_{B1}
Amplifier-gain G_{B1}
905-B
1-D Threshold Circuitry
Positive Peak Level PPL_B
Negative Peak Level NPL_B
906-B
2-D Circuitry
Differentiator
LPF-cutoff f_{B2}
Amplifier-gain G_{B2}
Zero Crossing Detector
907-A
Data Gate
908-B
909-A
1-Bit A/D
D_2
to Digitizer and Symbol Decoder
PATH B
901

FIG. 9

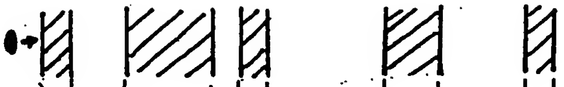


FIG. 10A Laser beam moving across bars and spaces

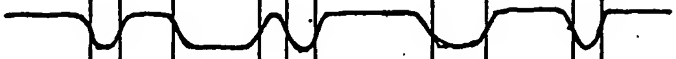


FIG. 10B Light Levels at Photodiode

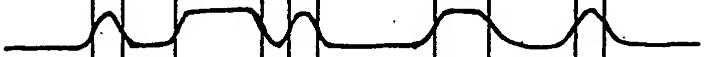


FIG. 10C Voltage Signal after signal conditioning

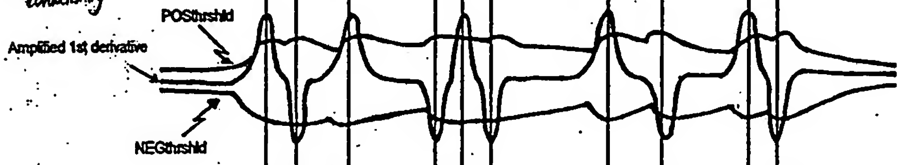


FIG. 10D

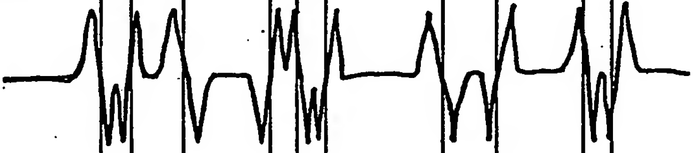


FIG. 10E 2nd Derivative

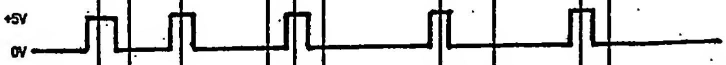


FIG. 10F Upper_ Threshold

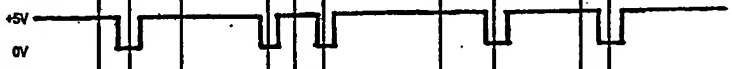


FIG. 10G Lower_ Threshold.

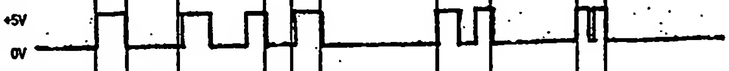


FIG. 10H 2nd Derivative zero-crossing detect

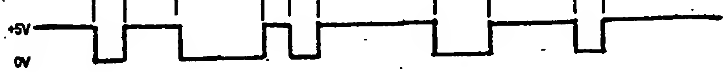
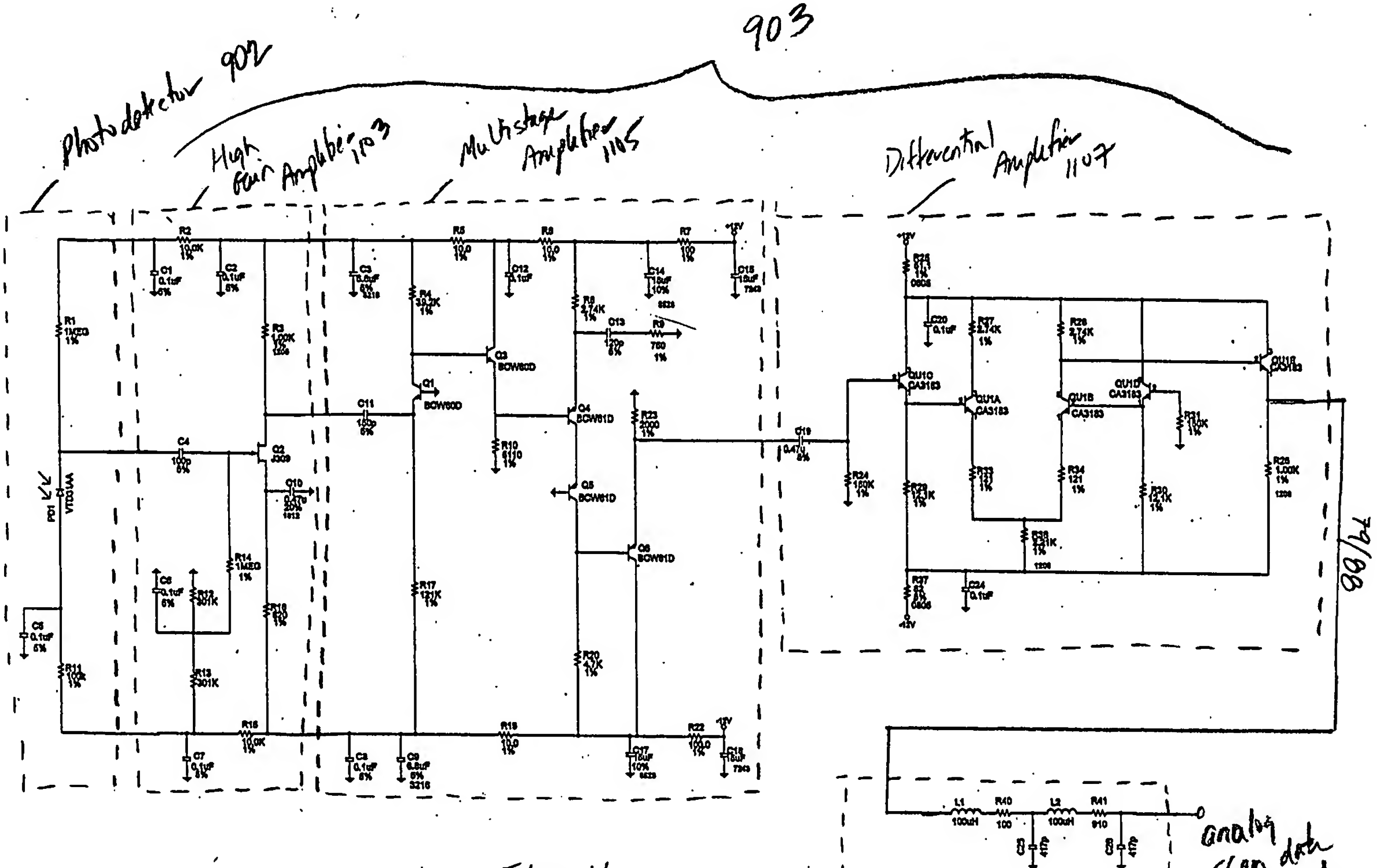


FIG. 10I Digital Scan Data Signal D_2


903
Photodetector 902
High Gain Amplifier 1103
Multistage Amplifier 1105
Differential Amplifier 1107
PD1
VTD31AA
R1
1MEG
1%
C5
0.1uF
5%
R11
100k
1%
R2
10.0K
1%
C1
0.1uF
5%
C2
0.1uF
5%
R3
1.00K
1%
1206
C4
100p
5%
Q2
J309
C10
0.47u
20%
1812
R14
1MEG
1%
C6
0.1uF
5%
R12
301K
R13
301K
R16
620
1%
R15
10.0K
1%
C7
0.1uF
5%
C3
6.8uF
5%
3216
C11
100p
5%
R4
30.2K
1%
Q1
BCW60D
Q3
BCW60D
R5
10.0
1%
R8
10.0
1%
C12
0.1uF
R10
6110
1%
R17
121K
1%
C8
0.1uF
5%
C9
6.8uF
5%
3216
R19
10.0
1%
R6
2.74K
1%
C13
120p
5%
R9
750
1%
Q4
BCW61D
Q5
BCW61D
Q6
BCW61D
R20
4.7K
1%
R23
2000
1%
R7
100
1%
+12V
C14
10uF
10%
6623
C15
10uF
7343
R22
100.0
1%
-12V
C17
10uF
10%
6623
C18
10uF
7343
C19
0.47u
5%
R24
150K
1%
+12V
R25
511
1%
0805
C20
0.1uF
QU1C
CA3183
R27
2.74K
1%
QU1A
CA3183
R28
2.74K
1%
QU1B
CA3183
QU1D
CA3183
R31
150K
1%
QU1E
CA3183
R29
12.1K
1%
R33
121
1%
R34
121
1%
R30
12.1K
1%
R38
2.21K
1%
1206
R26
1.00K
1%
1206
R37
51
5%
0805
C24
0.1uF
-12V
L1
100uH
R40
100
L2
100uH
R41
910
Low Pass Filter 1109
analog scan data signal

FIG, 11

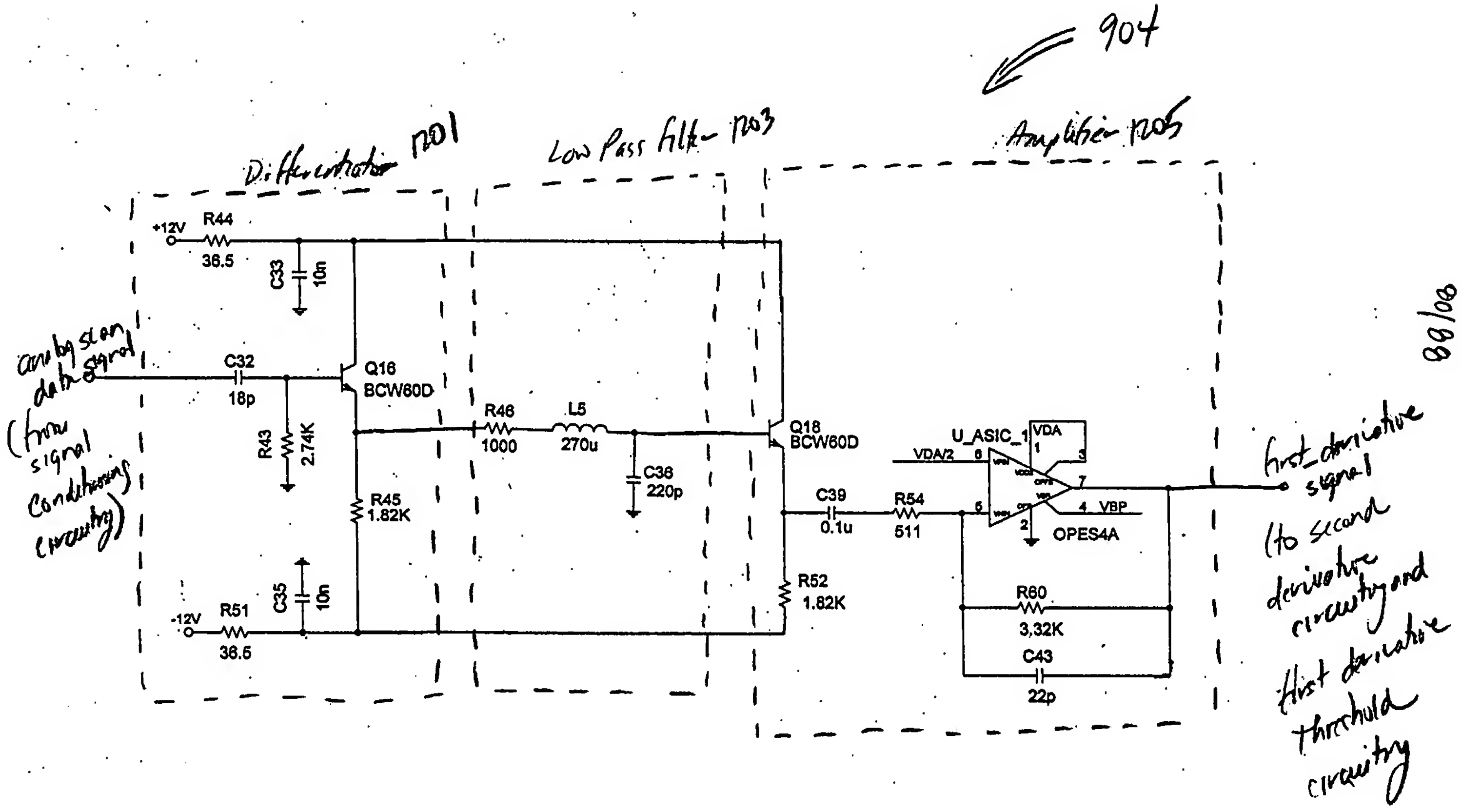

904
Differentiator 1201
Low Pass filter 1203
Amplifier 1205
analog scan data signal
(from signal conditioning circuitry)
+12V
R44
36.5
C33
10n
C32
18p
Q16
BCW60D
R43
2.74K
R45
1.82K
C35
10n
-12V
R51
36.5
R46
1000
L5
270u
C36
220p
Q18
BCW60D
C39
0.1u
R54
511
R52
1.82K
U_ASIC_1
VDA
1
3
VDA/2
6
7
5
2
4
VBP
OPES4A
R60
3,32K
C43
22p
first derivative signal
(to second derivative circuitry and first derivative threshold circuitry

FIG. 12

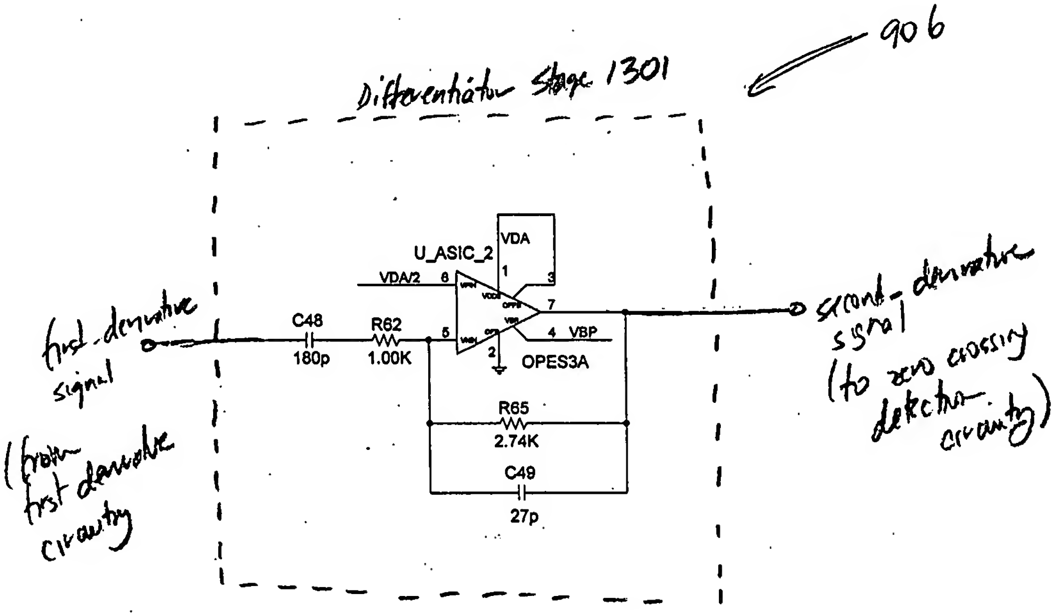

906
Differentiator Stage 1301
first-derivative signal
(from first derivative circuitry)
C48
180p
R62
1.00K
U_ASIC_2
VDA/2
8
VDA
1
3
5
2
7
4
VBP
OPES3A
R65
2.74K
C49
27p
second-derivative signal
(to zero crossing detector circuitry)

FIG. 13

81/88

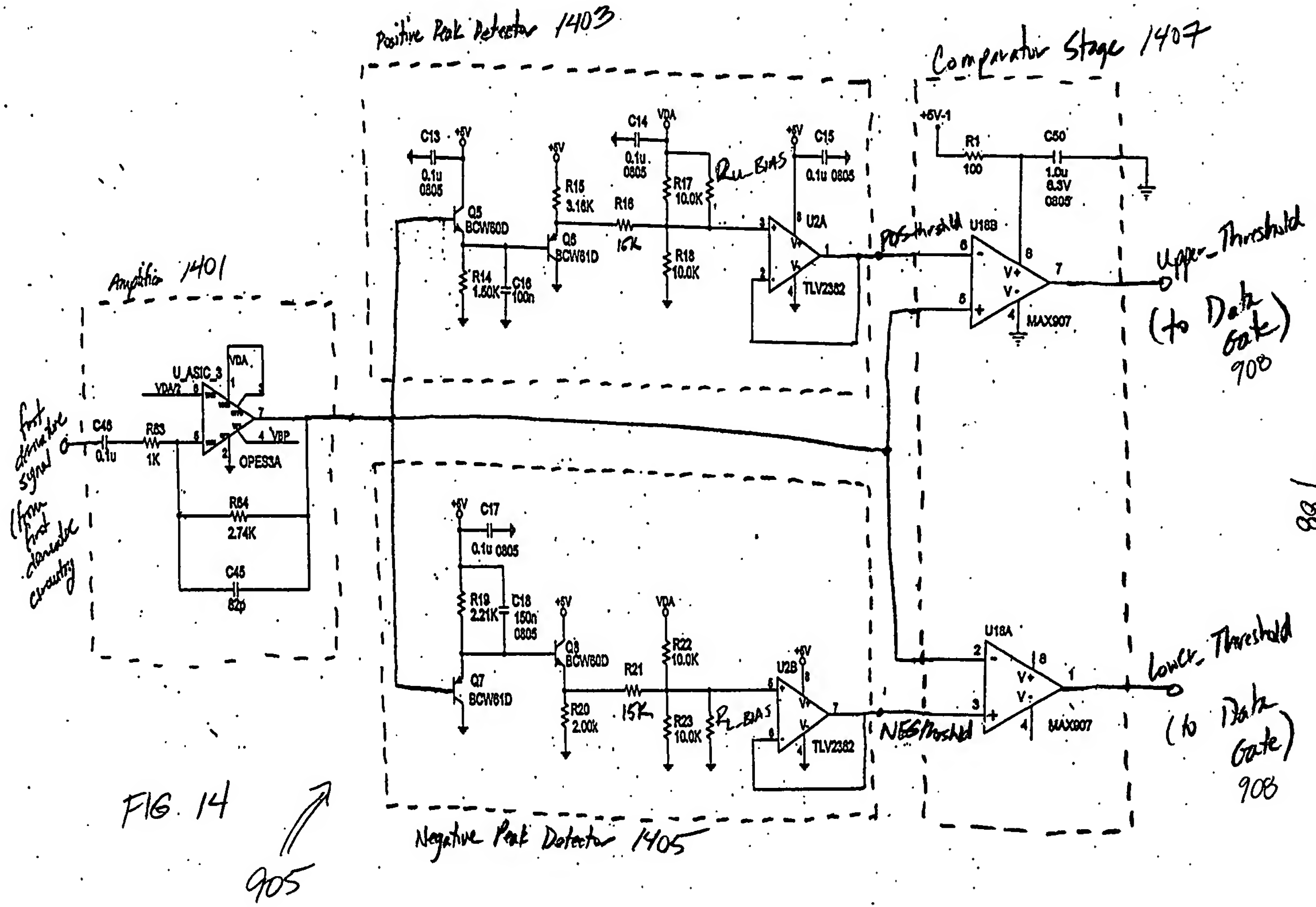

Positive Peak Detector 1403
Comparator Stage 1407
Amplifier 1401
first derivative signal (from first derivative circuitry)
C46
0.1u
R63
1K
U_ASIC_3
VDA/2
VDA
OPE53A
VBP
R64
2.74K
C45
82p
C13
+5V
0.1u
0805
Q5
BCW60D
R14
1.50K
C16
100n
+5V
R15
3.16K
Q6
BCW61D
R16
15K
C14
VDA
0.1u
0805
R17
10.0K
R18
10.0K
R_U_BIAS
+5V
C15
0.1u 0805
U2A
TLV2362
POS threshold
+5V-1
R1
100
C50
1.0u
6.3V
0805
U18B
MAX907
V+
V-
Upper_Threshold
(to Data Gate)
908
+5V
C17
0.1u 0805
R19
2.21K
C18
150n
0805
Q7
BCW61D
+5V
Q8
BCW60D
R20
2.00K
R21
15K
VDA
R22
10.0K
R23
10.0K
R_L_BIAS
U2B
+5V
TLV2362
NEG threshold
U18A
MAX907
Lower_Threshold
(to Data Gate)
908
Negative Peak Detector 1405
905

FIG. 14

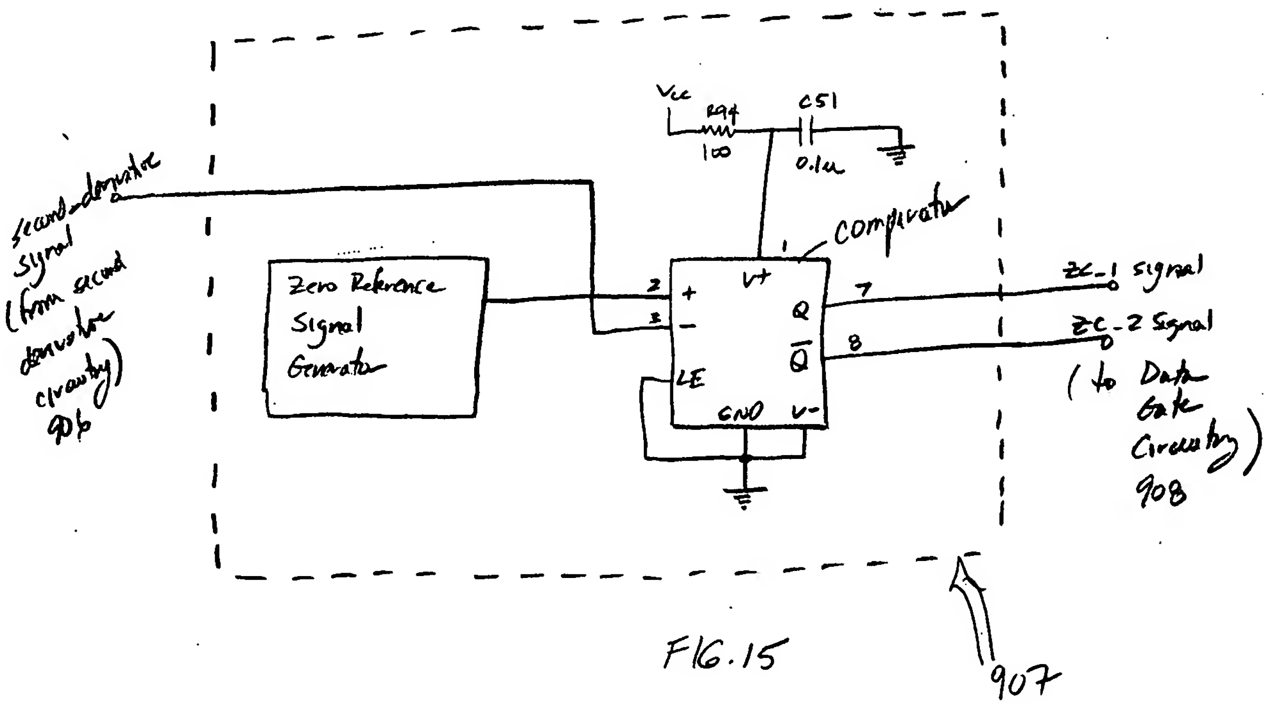

Vcc
R94
100
C51
0.1u
comparator
1
2
3
V+
+
−
Q
$\overline{Q}$
LE
GND
V−
7
8
Zero Reference Signal Generator
second-derivative signal (from second derivative circuitry) 906
ZC-1 signal
ZC-2 Signal
(to Data Gate Circuitry) 908
907

FIG. 15

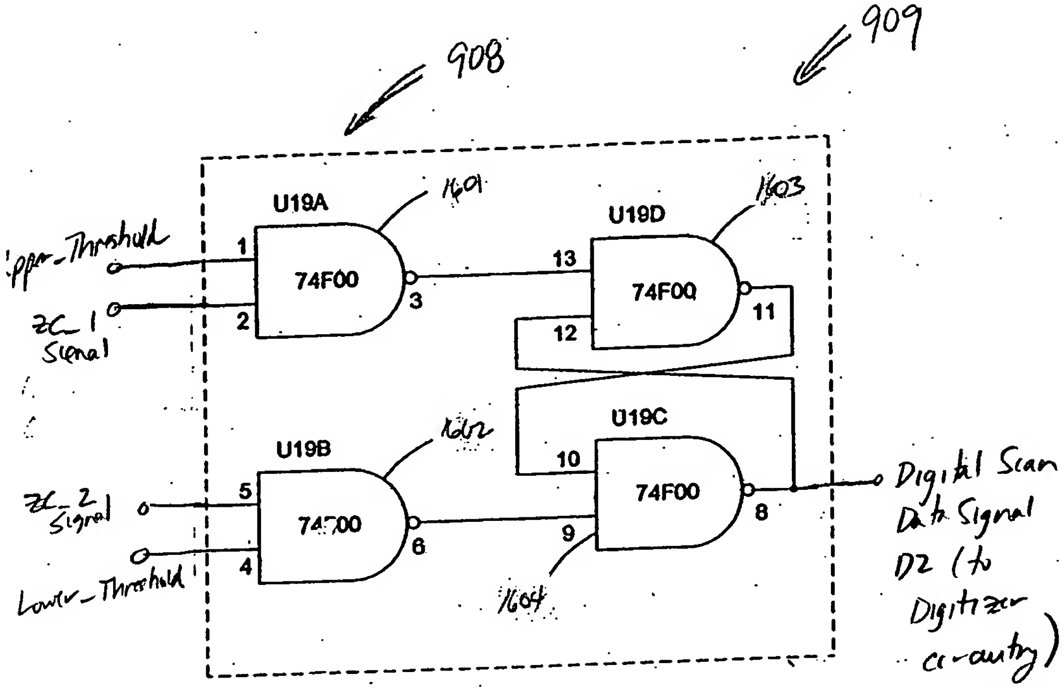

909
908
U19A
1601
74F00
1
2
3
Upper_Threshold
ZC_1 Signal
U19D
1603
74F00
13
12
11
U19B
1602
74F00
5
4
6
ZC_2 Signal
Lower_Threshold
U19C
74F00
10
9
8
1604
Digital Scan Data Signal D2 (to Digitizer circuitry)

FIG. 16

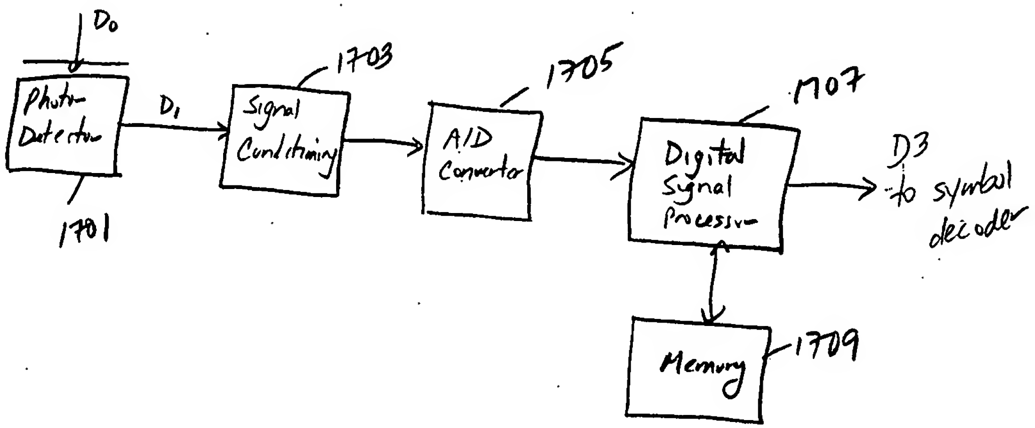

D0
Photo-Detector
1701
D1
Signal Conditioning
1703
A/D Converter
1705
Digital Signal Processor
1707
D3
to symbol decoder
Memory
1709

FIG. 17A

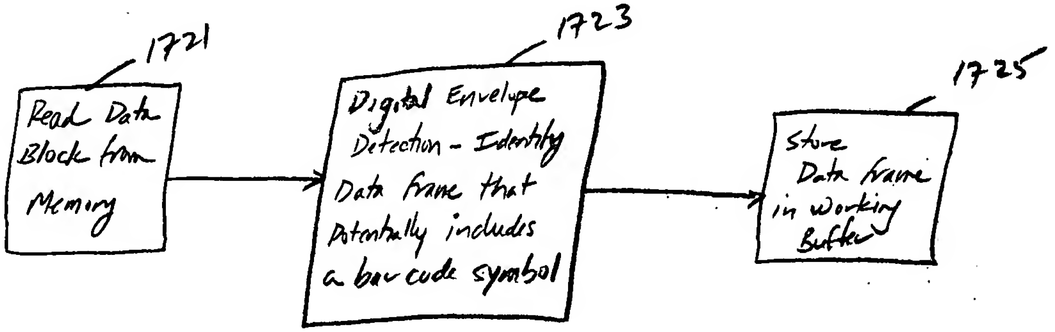

1721
Read Data Block from Memory
1723
Digital Envelope Detection - Identify Data frame that potentially includes a bar code symbol
1725
Store Data frame in working Buffer

FIG 17B

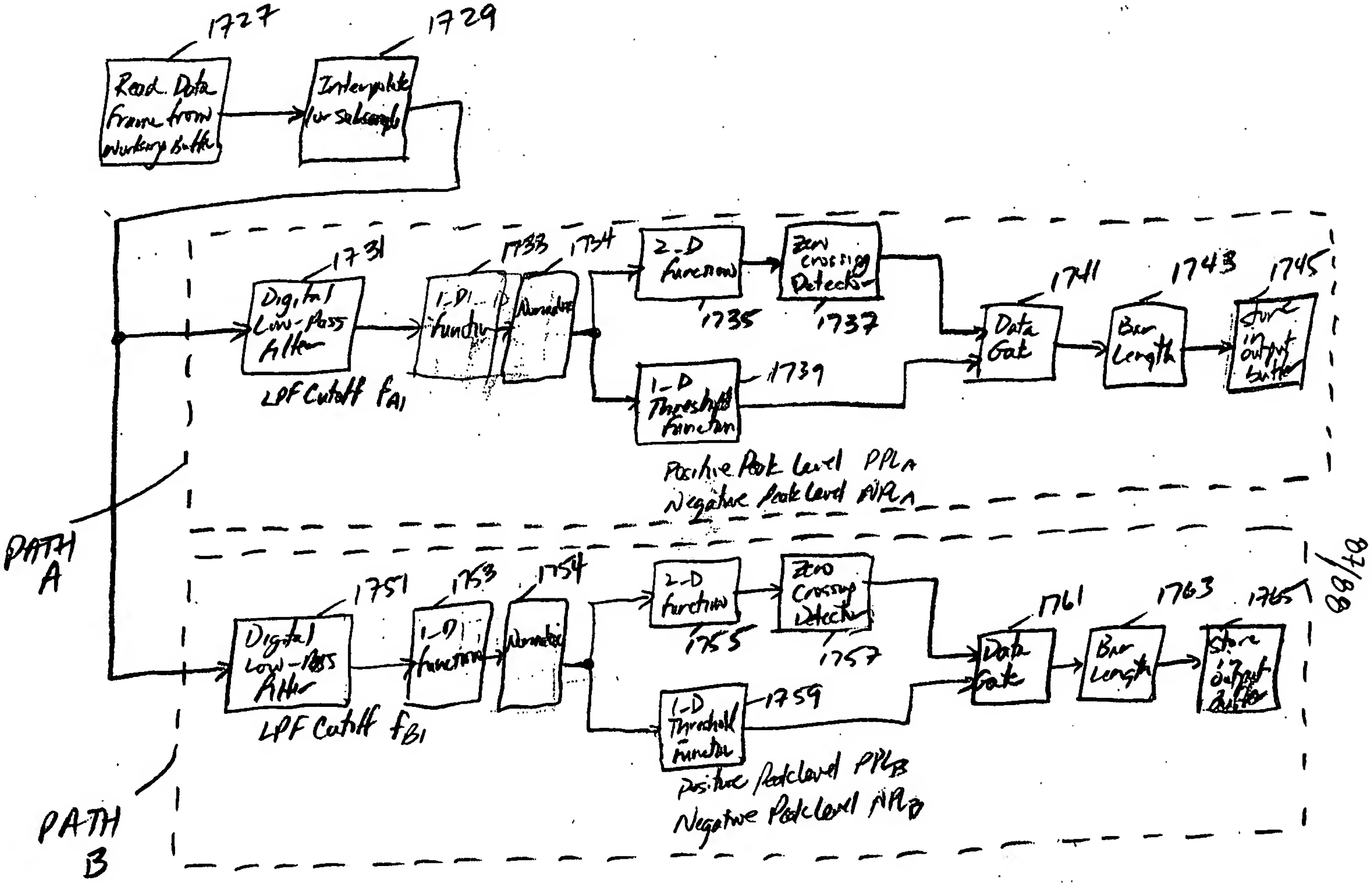

1727
Read Data Frame from working buffer
1729
Interpolate (or subsample)
PATH A
1731
Digital Low-Pass Filter
LPF Cutoff f_A1
1733
1-D function
1734
Normalize
2-D function
1735
Zero crossing Detector
1737
1-D Threshold Function
1739
Positive Peak Level PPL_A
Negative Peak Level NPL_A
1741
Data Gate
1743
Bar Length
1745
Store in output buffer
PATH B
1751
Digital Low-Pass Filter
LPF Cutoff f_B1
1753
1-D function
1754
Normalize
2-D function
1755
Zero Crossing Detector
1757
1-D Threshold function
1759
Positive Peak Level PPL_B
Negative Peak Level NPL_B
1761
Data Gate
1763
Bar Length
1765
Store in output buffer

FIG. 17C

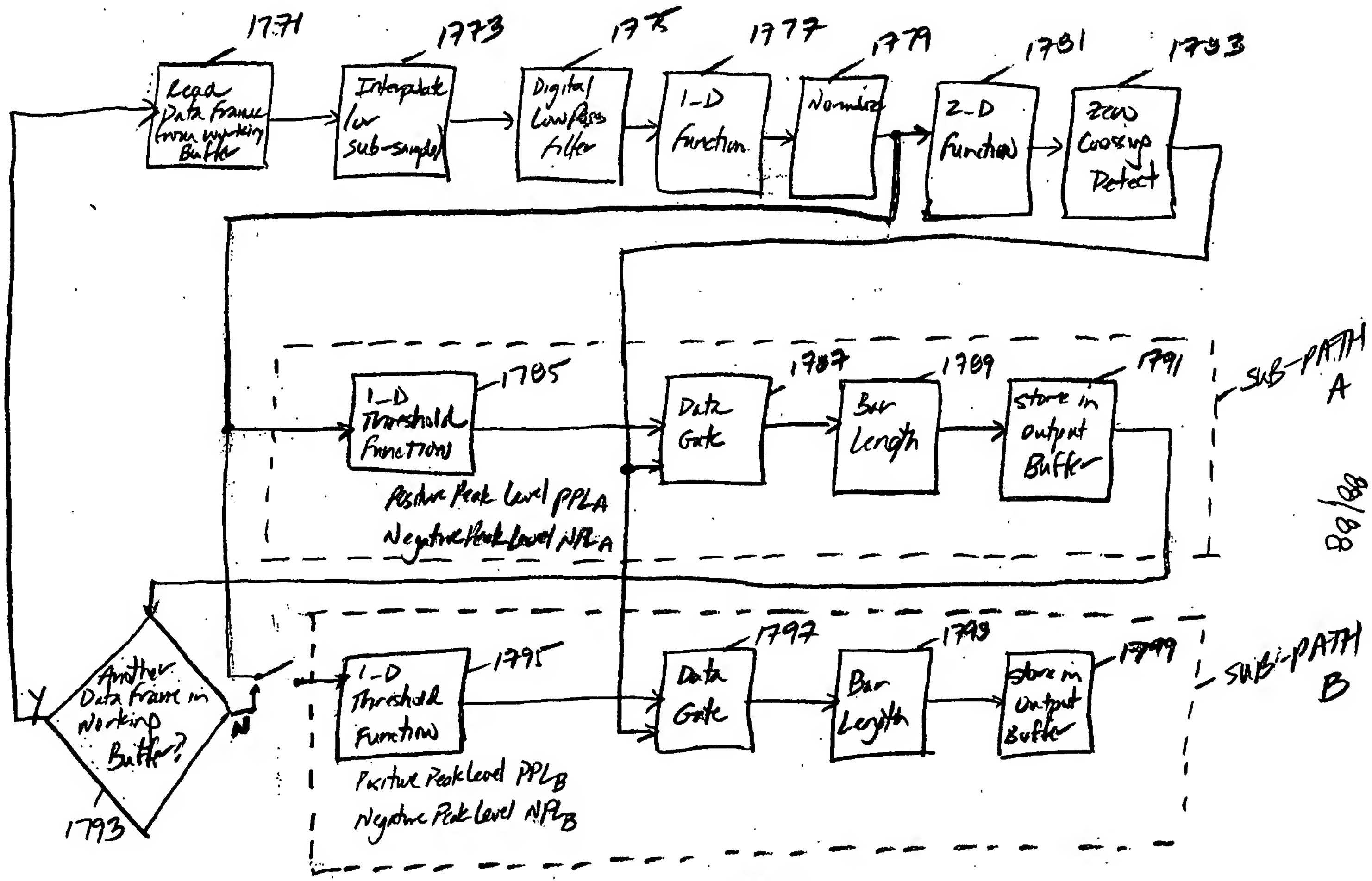

1771
Read Data Frame from working Buffer
1773
Interpolate for Sub-sample
1775
Digital LowPass Filter
1777
1-D Function
1779
Normalize
1781
2-D Function
1783
Zero Crossing Detect
1785
1-D Threshold Function
Positive Peak Level PPLA
Negative Peak Level NPLA
1787
Data Gate
1789
Bar Length
1791
store in output Buffer
SUB-PATH A
1795
1-D Threshold Function
Positive Peak Level PPL_B
Negative Peak Level NPL_B
1797
Data Gate
1798
Bar Length
1799
store in Output Buffer
SUB-PATH B
Another Data Frame in Working Buffer?
Y
N
1793

FIG. 17D